Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION
ENVIRONMENTAL RESTORATION PROJECT

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Environmental
Restoration
Project

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EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico is proposing a risk-based no further action (NFA) decision for Solid Waste Management Units (SWMU) 275, 10, 12B, 65E, 94A, 57A, 61A, 71, and 85. Review and analysis of all relevant data for these SWMUs indicate that concentrations of constituents of concern (COC) at these sites are less than applicable risk assessment action background levels. Thus, these SWMUs are proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that may have been released from the SWMUs into the environment pose an acceptable level of risk under current and projected future land use, as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998). Each of the above-listed SWMUs is briefly described below.

SWMU 275 (the Technical Area [TA] V Seepage Pits in Operable Unit [OU] 1306) contains two inactive septic tanks connected to six seepage pits. In 1994 preliminary investigations (including a subsurface active soil-gas survey that used direct-push borings and a surface passive soil-gas survey) were conducted at the site. Subsurface samples were taken from boreholes that had been drilled to the groundwater (520 feet) at the center of the seepage pit location. Based upon analysis results of these samples, the following residual COCs occur in isolated intervals within the borehole: metals, radionuclides, volatile organic compounds (VOC), and semivolatile organic compounds (SVOC). A separate ongoing groundwater investigation is being performed for the entire TA-V complex to address groundwater issues. The site assessment concludes that SWMU 275 does not have potential to affect human health under an industrial land use scenario. Because of the subsurface depth of the SWMU 275 seepage pits, no complete ecological pathways exist, and evaluation of ecological risk is not warranted.

SWMU 10 (the Burial Mounds in OU 1333) is an inactive site that contains primarily soil/debris from salvage operations that had been conducted after an accidental detonation of two mock weapons inside a bunker at the site. A radiological voluntary corrective measure (VCM) activities were performed in March 1995 and April—May 1996 to remove sources of radiological anomalies. A voluntary corrective action was taken in May 1998 to remove the vermiculite mound. The site assessment concludes that SWMU 10 does not have potential to affect human health under an industrial land-use scenario. After considering the uncertainties of related available data and modeling assumptions, it was determined that ecological risks associated with SWMU 10 were very low.

SWMU 12B (the Burial Site [Lurance Canyon] in OU 1333) is one of two subunits comprising SWMU 12. SWMU 12A (the Open Dump) had been previously submitted for an NFA decision in May 1997. SWMU 12B is located within the graded portion of SWMU 65D (the Lurance Canyon Explosive Test Site [LCETS]). The site is associated with debris generated during testing operations and historical grading activities in support of current Lurance Canyon Burn Site (LCBS) operations. In 1997 a VCM was performed at the site to excavate and characterize all fill material in the arroyo. The arroyo drainage was reestablished and stabilized. Analysis revealed the following residual COCs at SWMU 12B: metals, radionuclides, high explosives (HE), VOCs, and SVOCs. The site assessment concludes that SWMU 12B does not have significant potential to affect human health under a recreational land-use scenario. After

considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 12B were low.

SWMU 65E (the Far-Field Dispersion Area in OU 1333) is the farthest extent (far-field) fragmentation area associated with open-detonation tests at the LCETS. A radiological VCM was conducted at the site in March 1995, during May—June 1996, and in October 1996. Radiological VCM activities were conducted during March 1995 and May, June, and October 1996. Point sources and small area sources were removed in March 1995. Larger area sources were remediated in May, June, and October 1996. Sampling analysis revealed residual metals and radionuclides at the SWMU. The site assessment concludes that SWMU 65E does not have potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 65E were very low.

SWMU 94A (the LCBS Aboveground Tanks in OU 1333) is comprised of three aboveground storage tank locations: one active and two inactive areas where the tanks have been emptied and/or removed. The NFA addresses historical releases from all three aboveground storage tank locations. However, the active aboveground storage tank location is operating in compliance with all current applicable federal and state regulations and is not regulated under the Resource Conservation and Recovery Act. The aboveground storage tanks were used to store JP-4 and water in support of testing operations at the LCBS. Confirmatory sampling analysis at the site revealed the following COCs at the site: radionuclides, VOCs, and SVOCs. The site assessment concludes that SWMU 94A does not have significant potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 94A were very low.

SWMU 57A (the Workman Site: Firing Site in OU 1334) is a former artillery firing area that was active during World War II for the development of the proximity fuse—a radar-activated, variable-timed bomb fuse used in antiaircraft defense munitions. A variety of artillery pieces were used to fire test shells at targets suspended between the two former towers at SWMU 57B (the Workman Site: Target Area) located approximately 2 miles to the east. Confirmatory sampling analysis identified the following COCs at the site: metals, radionuclides, residual HE, SVOCs, VOCs, and polychlorinated biphenyl. The site assessment concludes that SWMU 57A does not have significant potential to affect human health under an industrial-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 57A were low.

SWMU 61A (the Schoolhouse Mesa Test Site: Blast Area in OU 1334) is an inactive explosives test site located within the former Area Z explosives testing area. SWMU 61A contains a previously cleared area, one long low debris mound located southwest of the cleared area, a second former debris mound located northwest of the cleared area, and three concrete blocks. Both mounds were dismantled during confirmatory sampling. A radiological VCM was performed in March 1995 and in February, March, May, July, and October 1996. Sampling analysis revealed the following residual COCs at the SWMU: metals, radionuclides, HE, VOCs, and SVOCs. The site assessment concludes that SWMU 61A does not have potential to affect human health under an industrial land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 61A were low.

SWMU 71 (the Moonlight Shot in OU 1334) is an explosives test site that was active from 1956 to 1961. Testing activities examined the possible radioactive fallout dispersion patterns that could result from a noncritical weapon detonation during transport or assembly scenarios. These airborne dispersion tests used depleted uranium in place of fissionable materials and yielded no nuclear fission products. A radiological VCM was performed during January—March 1995 and January—March 1996. Confirmatory sampling analysis revealed the following residual COCs at the SWMU: metals, radionuclides, and residual HE. The site assessment concludes that SWMU 71 does not have potential to affect human health under an industrial land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 71 were insignificant.

SWMU 85 (the Firing Site [Building 9920] in OU 1335) is an active test site where both aboveground and subsurface firing tests and reactor meltdown tests have been performed. A radiological VCM was performed in July and September 1995 and during March—June 1996. Sampling analysis revealed residual metals and HE COCs at the site. The site assessment concludes that SWMU 85 does not have significant potential to affect human health under an industrial land-use scenario. After consideration of the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 85 were insignificant.

REFERENCES

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, New Mexico Environment Department, Santa Fe, New Mexico.

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOC	area of concern
AR/COC	analysis request/chain-of-custody
BCF	bioconcentration factor
bgs	below ground surface
BH	borehole
BLM	Bureau of Land Management
BTEX	benzene, toluene, ethylbenzene, and xylene
C	concrete sample
CA	Corrective Action
CCTA	Central Coyote Test Area
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter(s)
cm^2	square centimeter(s)
COC	constituent of concern
COPEC	constituent of potential ecological concern
cps	count(s) per second
CTA	Coyote Test Area
CY	Canyon
D	debris sample
DCF	dose conversion factor
DOE	U.S. Department of Energy
dpm	disintegration(s) per minute
DQO	Data Quality Objective
DU	depleted uranium
EB	equipment blank
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERCL	Environmental Restoration Chemistry Laboratory
FCI	fuel coolant interaction
FITS	Fully Instrumented Test System
FOP	field operating procedure
ft	feet
g	gram(s)
GC	gas chromatography
GEL	General Engineering Laboratories
GPS	Global Positioning System
GR	grab sample
HASP	health and safety plan
HE	high explosive(s)
HEAST	Health Effects Assessment Summary Tables

ACRONYMS AND ABBREVIATIONS (Continued)

HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HP	Health Physics
HRMB	Hazardous and Radioactive Materials Bureau
HRS	Hazard Ranking System
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments
ID	identification
I.D.	inner diameter
IH	Industrial Hygiene
IRIS	Integrated Risk Information System
KAFB	Kirtland Air Force Base
kg	kilogram(s)
L	liter(s)
LAARC	Light Airtransport Accident Resistant Container
LAS	Lockheed Analytical Services
lb	pound(s)
LCETS	Lurance Canyon Explosives Test Site
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOAEL	lowest-observed-adverse-effect level
Log	logarithm (base 10)
LWDS	Liquid Waste Disposal System
m^3	cubic meter(s)
MDA	minimum detectable activity
MDC	melt development corium
MDL	method detection limit
mg	milligram(s)
mi	mile(s)
mL	milliliter(s)
mrem	millirem(s)
MS	mass spectrometry; matrix spike
MSD	matrix spike duplicate
µg	microgram(s)
µR/hr	microroentgen(s) per hour
NC	not calculated
ND	not detected
NFA	no further action
NG	nitroglycerin
NLM	National Library of Medicine
NMED	New Mexico Environment Department
NOAEL	no-observed-adverse-effect level
NRC	U.S. Nuclear Regulatory Commission
NT	not tested

ACRONYMS AND ABBREVIATIONS (Continued)

O.D.	outside diameter
OB	Oversight Bureau
OP	operating procedure
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi	picocurie(s)
PID	photoionization detector
ppbv	part(s) per billion by volume
PPE	personal protective equipment
ppm	part(s) per million
PQL	practical quantitation limit
PRG	preliminary remediation goals
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RCT	radiation control technician
RDX	1,3,5-trinitro-1,3,5-triazacyclohexane
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RME	reasonable maximum exposure
RMMA	Radioactive Materials Management Area
RP	Radiation Protection
RPD	relative percent difference
RPSD	Radiation Protection Sample Diagnostics
RSI	Request for Supplemental Information
S	soil sample
SAP	sampling and analysis plan
SD	soil sample duplicate
SFN	silt fence (north)
SFSW	silt fence (southwest)
SNL/NM	Sandia National Laboratories/New Mexico
SOV	soil organic vapor
SSO	soil sample
SVOC	semivolatile organic compound
SVS	soil vapor survey
SWHCP	Site-Wide Hydrogeologic Characterization Project
SWMU	solid waste management unit
SWTA	Southwest Test Area
TA	Technical Area
TABS	Torch-Activated Burn System
TAL	target analyte list

ACRONYMS AND ABBREVIATIONS (Concluded)

TCE	trichloroethylene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
Tetryl	2,4,6-trinitrophenylmethylnitramine
TIC	total ion counts
TPH	total petroleum hydrocarbon
US	soil sample
USAF	U.S. Air Force
USFS	U.S. Forest Service
UTL	upper tolerance limit
UXO	unexploded ordnance
XRF	x-ray fluorescence
VCM	voluntary corrective measure
VOC	volatile organic compound
WACC	Water Quality Control Commission
yr	year

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) Proposals for nine Environmental Restoration (ER) Solid Waste Management Units (SWMUs). The following SWMUs are listed in the Hazardous and Solid Waste Amendments Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992). Proposals for each SWMU are located in this document as follows:

Operable Unit 1306

- SWMU 275, TA-V Seepage Pits (Section 2.0)

Operable Unit 1333

- SWMU 10, Burial Mounds (Section 3.0)
- SWMU 12B, Burial Site (Section 4.0)
- SWMU 65E, Far-Field Dispersion Area, Lurance Canyon Explosive Test Site (Section 5.0)
- SWMU 94A, Aboveground Tanks, Lurance Canyon Burn Site (Section 6.0)

Operable Unit 1334

- SWMU 57A, Workman Test Site: Firing Site (Section 7.0)
- SWMU 61A, Schoolhouse Mesa Test Site: Blast Site (Section 8.0)
- SWMU 71, Moonlight Shot Area (Section 9.0)

Operable Unit 1335

- SWMU 85, Firing Site (Building 9920) (Section 10.0)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision.

10.0 SOLID WASTE MANAGEMENT UNIT 85

10.1 Summary

Solid Waste Management Unit (SWMU) 85, Firing Site (Building 9920), is an active test site where both aboveground and subsurface firing tests and reactor meltdown tests were performed. Constituents of concern (COC) are high explosives (HE) and metals, particularly depleted uranium (DU) and beryllium. A radiological voluntary corrective measure (VCM) was performed on the site, and confirmation samples were collected. Review and analysis of all relevant data for SWMU 85 indicate that average concentrations of COCs at this SWMU are less than (1) Sandia National Laboratories/New Mexico (SNL/NM) or other applicable background limits; or (2) Proposed Subpart S or other action levels; or (3) applicable risk assessment action levels. Thus, SWMU 85 is being proposed for a no further action (NFA) decision based upon confirmatory sampling data demonstrating that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land uses, per NFA Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

10.2 Description and Operational History

Section 10.2 describes SWMU 85 and discusses its operational history.

10.2.1 Site Description

SNL/NM Environmental Restoration (ER) SWMU 85, (Figure 10.2.1-1) is located in the Coyote Test Field Area, 1,500 feet east of Technical Area III. The site encompasses four areas in the vicinity of Building 9920. SWMU 85 is on land owned by the U.S. Air Force (USAF), permitted to the U.S. Department of Energy (DOE) and SNL/NM. It is comprised of four firing sites that cover approximately 14.3 acres. The mean elevation of the site is 5,454 feet above sea level (SNL/NM March 1996a). Current and projected land uses for SWMU 85 are industrial.

SWMU 85 lies on the western margin of the Sandia Fault Zone. The geologic material underlying the site consists of thick alluvial sediments that overlie deep bedrock. An alluvial fan and piedmont colluvium overlie the Santa Fe Group Strata. The Santa Fe deposits are estimated to be approximately 3,000 feet thick beneath SWMU 85. The Site-Wide Hydrogeologic Characterization Project (SWHCP) 1994 Annual Report (SNL/NM March 1995) describes the regional geology.

SWHCP soil surveys and surficial mapping provide general soil characteristics for the area around SWMU 85. The dominant soil groups in the area include the Tome very fine sandy loam, and the Tijeras gravely fine, sandy loam. The soils underlying the site are defined as the Tijeras gravely fine sandy loam. The estimated recharge rate for soils in the area range from between 0.002 and 0.071 centimeter (cm) year (yr), which yields downward seepage velocities ranging between 0.03 and 11.8 cm/yr (SNL/NM October 1995).

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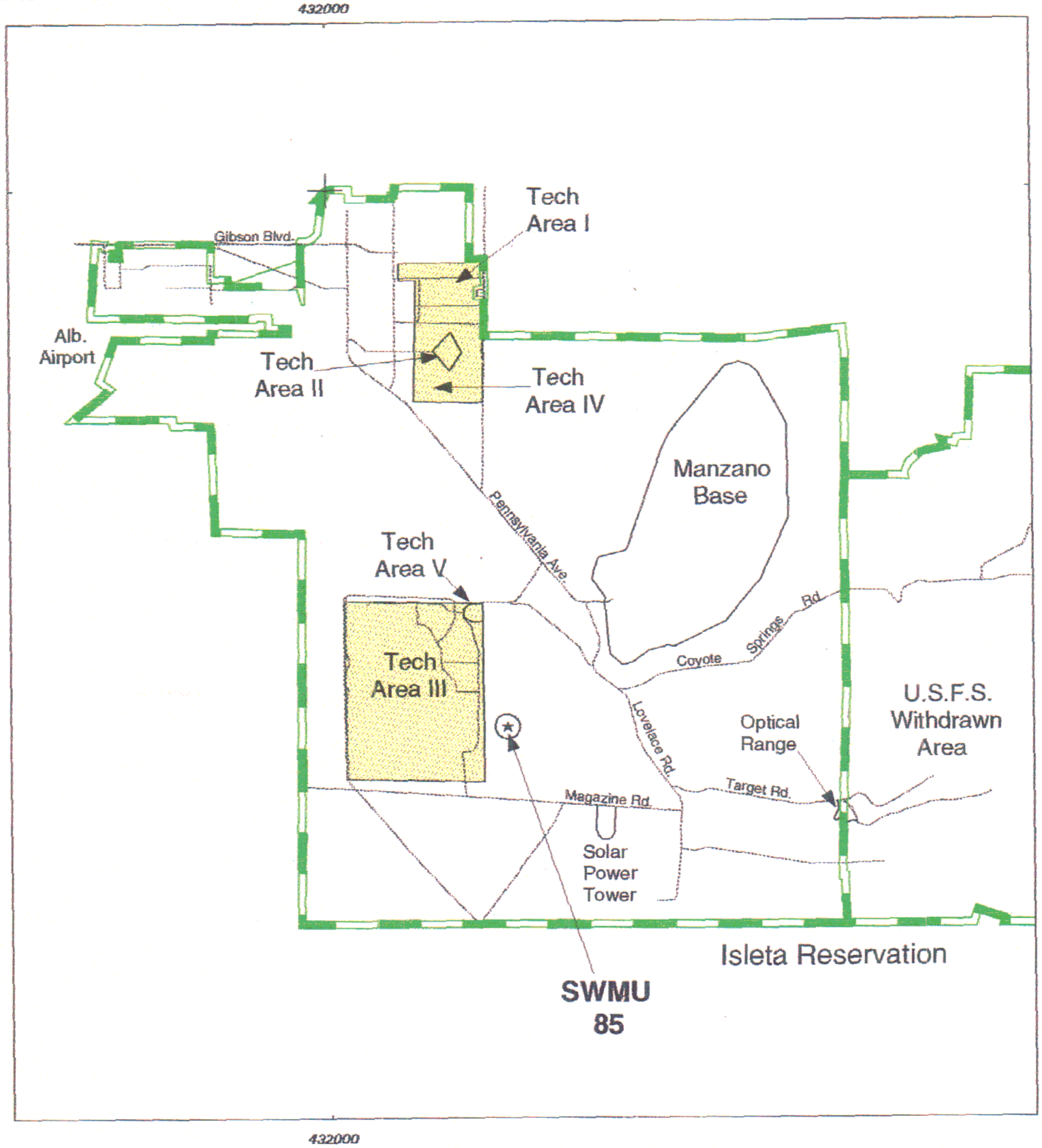

Legend

- SWMU 85
- Major Road
- KAFB Boundary
- Technical Area

Figure 10.2.1-1
Location Map for SWMU 85
Sandia National Laboratories
New Mexico

0 5000 10000
Scale in Feet

0 1200 2400
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

No perennial surface-water bodies are present in the immediate vicinity of SWMU 85. The nearest surface drainage is the ephemeral water course of an unnamed arroyo located approximately 1,000 feet north of Building 9920. SWMU 85 is situated between two tributaries that form this arroyo. The arroyo flows into an internal drainage basin.

SWMU 85 lies in the HR-2 geohydrologic region described in the SWHCP 1994 annual report (SNL/NM March 1995). This region is an intermediate geohydrologic zone between the HR-1 zone to the west and the HR-3 zone to the east. It is comprised of a northeast/southwest-trending fault complex, which includes segments of the Sandia, the Tijeras, and the Hubbell Springs Faults.

The uppermost interval of groundwater saturation in HR-2 will be found as unconfined to semiconfined aquifers in the alluvial facies of the Santa Fe Group and Piedmont alluvium, and as semiconfined to confined aquifers in the local bedrock units. Examples of these two aquifer models are found in two wells located near the site. Monitoring well STW-1, which is 6,100 feet southeast of Building 9926, is screened in the Tertiary Conglomerates. Depth to groundwater in this well is 155 feet below ground surface (bgs). Monitoring well LMF-1 is 6,800 feet southeast of the site. Depth to groundwater in this well is 347 feet bgs. This well is screened in the Abo Sandstone (SNL/NM March 1996b).

For a detailed discussion of the local setting at SWMU 85, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation [RFI] Work Plan for Operable Unit 1335, Foothills Test Area" (SNL/NM March 1996a).

10.2.2 Operational History

Four firing site/test areas are associated with SWMU 85 (Figures 10.2.2-1 and 10.2.2-2). Explosives were limited to 50 pounds or less during testing. Building 9920 was the control room for the firing sites (Gaither October 1991). Firing Site 1 is located directly west of Building 9920 and is defined by a 20- by 30-foot area adjacent to the building and a smaller 10- by 10-foot area northwest of the building. Firing Site 2 is a series of tanks and pressure vessels, known as the VGES (source of this acronym is unknown) tanks, located about 140 feet west of Building 9920. Firing Site 3 is the former location of an inflatable building. Site 3 was sampled in April 1997, and underwent a risk screening assessment in September 1997, which showed no significant risk (Fate June 1997). Firing Site 4 is the location of the Cable Suspension Facility, which is approximately 1,300 feet northwest of Building 9920.

Firing Site 1 is comprised of six small pits excavated to a depth of 6 to 8 feet (Author [unk] Date [unk], Perkins December 1984, Martz October 1985a). Beryllium disks (approximately 100 grams total) were placed in the pits. When an explosive charge was placed on top of the disks and detonated, the beryllium was propelled downward (Author [unk] Date [unk], Perkins December 1984). It is believed that the pit openings were plugged with concrete before the firing tests were conducted (Martz October 1985b). After each test, the pits were covered with approximately 6 inches of soil and ultimately backfilled (Perkins December 1984, SNL/NM and ITRI April 1988). Locations of these pits were believed to be either between Building 9920 and the two cable run boxes west of the building, or 30 to 50 feet west of the cable run boxes (Author [unk] Date [unk], Young January 1996).

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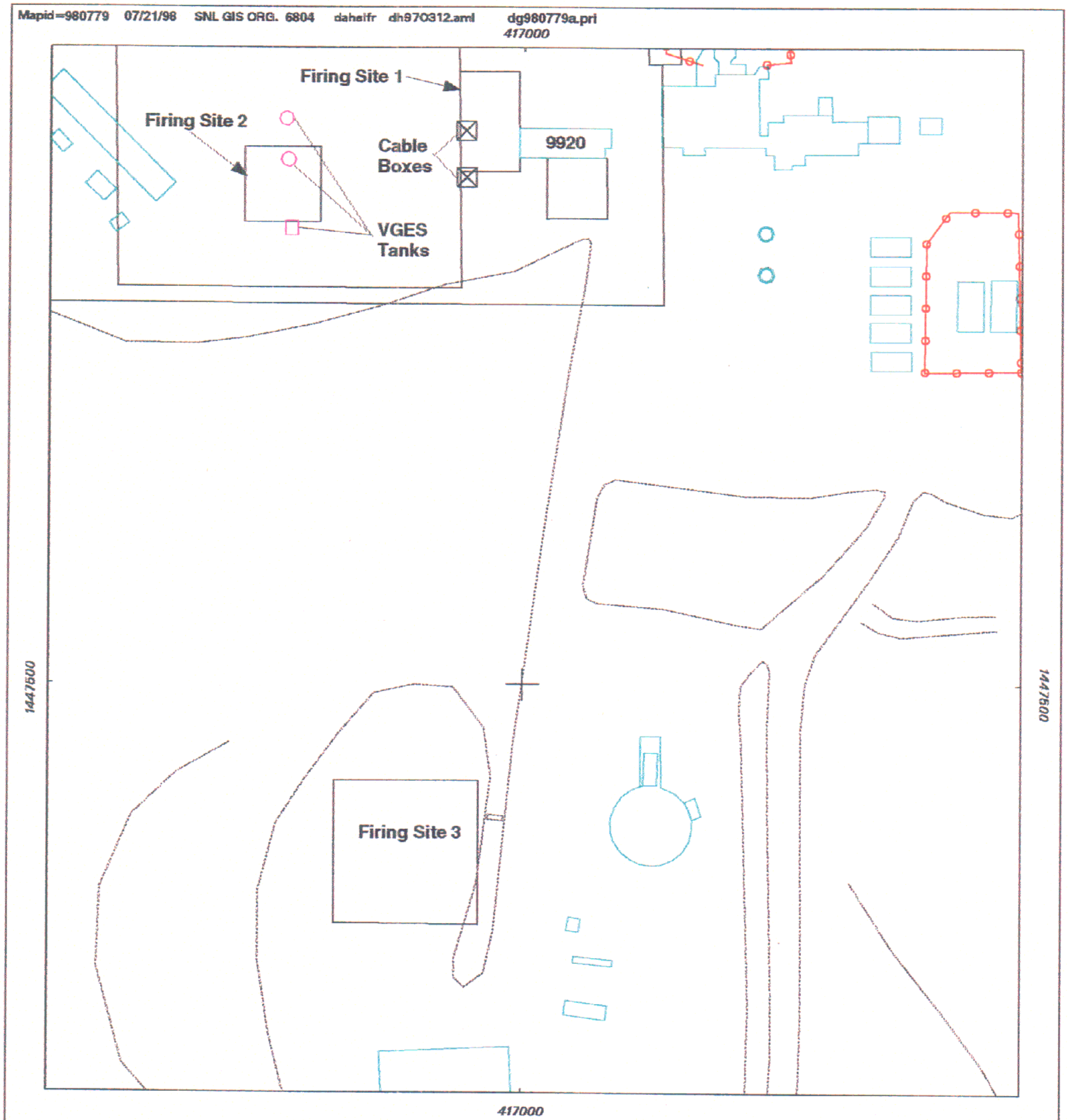

Legend

⊠	Cable Box
	Road
	Building/Structure
	Fence
	VGES Tank Location
	SWMU

Figure 10.2.2-1
SWMU 85
Firing Site 1, 2 & 3

0 50 100
Scale in Feet

0 12 24
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

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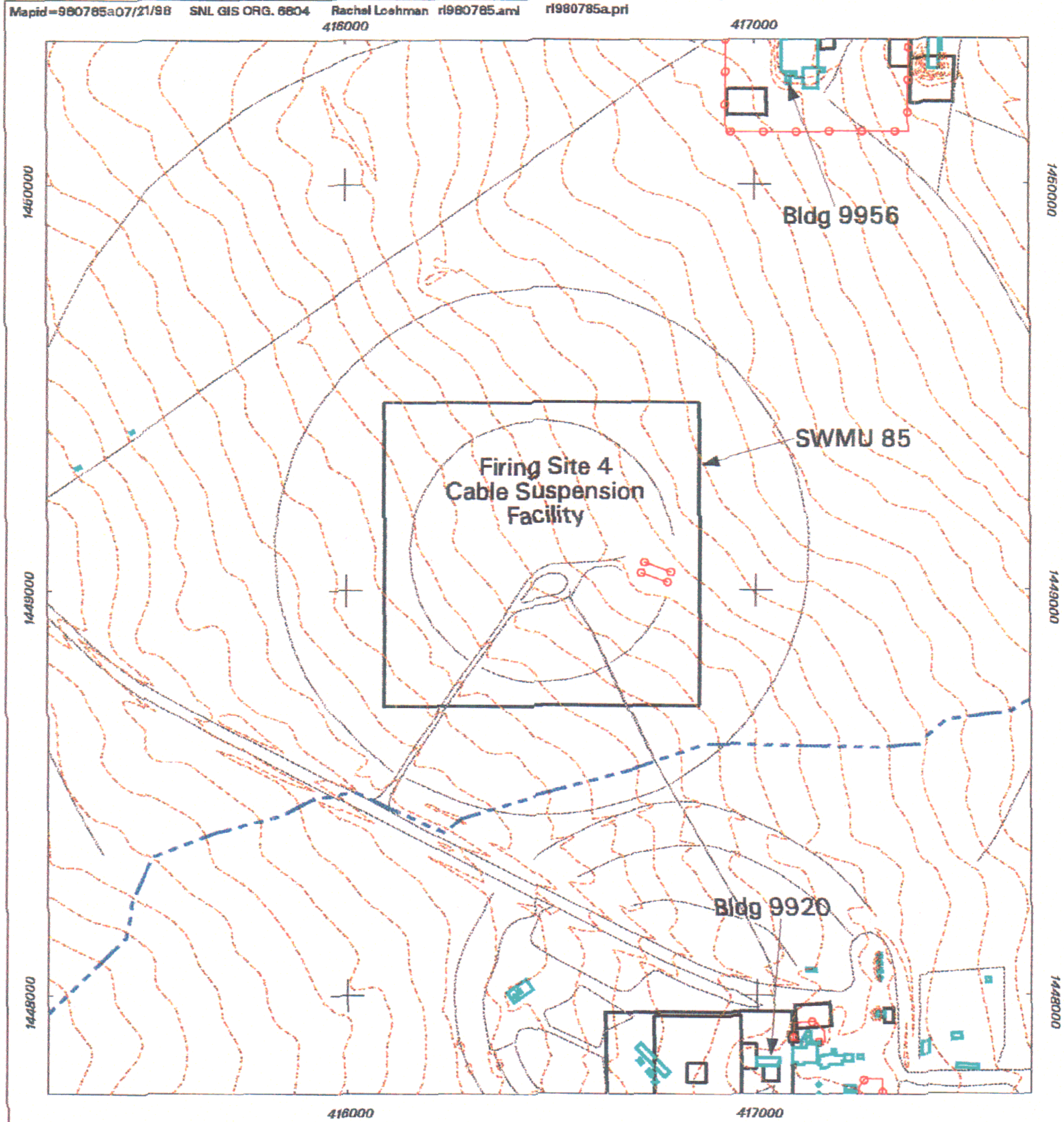


Legend

Road
2 Foot Contour
Drainage
Fence
Building
SWMU Site

Figure 10.2.2-2
SWMU 85
Firing Site 4

0 200 400
Scale in Feet

0 48 96
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Firing Site 2 is associated with tests conducted in the late 1970s that involved simulating reactor core meltdown scenarios by submerging molten core material in a large VGES tank containing water and observing the reaction (Perkins December 1984, Martz October 1985a, SNL/NM Date [unk]a, Marshall September 1993). The simulated core material, called corium thermite, was comprised of an alloy of zirconium, nickel oxide, chromium oxide, iron oxide, molybdenum oxide, and about 40 kilograms (kg) of DU (Perkins December 1984, Martz October 1985a, SNL/NM Date [unk]a, Marshall September 1993, Author [unk] Date [unk]). These tests contaminated the soil around the VGES tank with DU (Marshall September 1993). The core material was deposited in the area and the water was pumped onto the ground. The area was later graded.

An aerosol experiment using 100 grams of cesium iodide was also performed in a tank. This tank was vacuumed afterward, and approximately 90 percent of the cesium iodide was recovered (Perkins December 1984).

Dispersion tests were conducted on the surface at either Firing Site 1 or Firing Site 2. These involved blowing up small discs of cadmium sulfide (100 grams total) using 10,000 to 11,000 grams of manganese dioxide per shot. Also tests were performed using lithium hydride shots in an unspecified area (Martz September 1985, Young and Wrightson April 1995). Although the specific locations of these tests are not known, it is believed that they took place in the general areas of Firing Sites 1 and 2.

Firing Site 3 occupies the area known as the "old air building," which was an inflatable building. A series of eight dispersion tests were conducted within the building (Marshall September 1993). Each test involved a charge of 47 to 220 grams of DU powder and 0.5 pound of Composition 4 (0-4) HE. The charge was detonated to study the dispersion of DU while the building trapped the emissions. Plastic sheeting was placed on the unpaved floor of the building to capture the dispersed DU. After the test, aerosolized uranium was allowed to settle onto the plastic, which was then rolled up and disposed of in the Mixed Waste landfill (Marshall September 1993). The inflatable building has since been removed from the site.

The first test program conducted at the Cable Suspension Facility, Firing Site 4, was the SSAGE-2 tests series. This largest firing site at SWMU 85 covers an area of 13.2 acres. A sphere containing approximately 220 grams of DU was detonated using 0.5 pound of C-4 HE. The sphere fragmented into large pieces rather than aerosolizing as planned. Site personnel recovered about 100 of the 220 grams of DU from this test. This was the only DU experiment conducted at this facility (Marshall September 1993). Approximately 50 to 100 pounds of baratol, which contains barium nitrate, were used in some of the tests at this location. The barium oxide from the explosion was dispersed into the area and was deposited on the soil in the vicinity of the test area (Marshall September 1993).

Most recent testing primarily involved shock-wave experiments using air detonations of hydrogen. Methyl acetylene-propene-propadiene gas and bromofluoromethane were also used. These tests were performed in the structure (flame pad) directly west of Firing Site 2. Because the explosives were gases, no residual material remained in the environment. Therefore, the flame pad area was not investigated.

COCs at SWMU 85 include DU, HE, and metals, particularly beryllium.

10.3 Land Use

10.3.1 Current

SWMU 85 is on land owned by the USAF permitted to DOE and SNL/NM. Current land use is industrial, as a firing test site by SNL/NM Organization 6314.

10.3.2 Future/Proposed

SWMU 85 has been recommended for a future land use of industrial (DOE and USAF March 1996).

10.4 Investigatory Activities

SWMU 85 has been characterized and/or remediated in a series of three investigations. Section 10.4 discusses the investigatory activities.

10.4.1 Summary

SWMU 85 was initially investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s, which included nonsampling data collection (initial interviews, records search, literature survey, etc.) and a site inspection (Investigation #1). Beginning in 1994 preliminary investigations were conducted that included unexploded ordnance (UXO)/HE, radiological, cultural-resources, sensitive-species, and a geophysical survey (Investigation #2). RFI sampling was performed in 1997 (Investigation #3).

10.4.2 Investigation #1—Comprehensive Environmental Assessment and Response Program

10.4.2.1 Nonsampling Data Collection

SWMU 85 was originally reported in the 1985 CEARP interviews (DOE September 1987). Several firing tests were conducted at locations where approximately 6 kg of beryllium was placed in pits about 6 feet wide, and an explosive charge was detonated in these pits. The material was reportedly never removed but was covered with concrete and marked with stakes; however, the stakes could not be found during the CEARP investigation.

Other tests described in the CEARP include surface firing tests involving small discs containing cadmium sulfide (100 grams total). Other materials reportedly released at SWMU 85 include small quantities of toluene, methanol, isopropyl alcohol, acetone, and inorganic acids that were used for cleaning.

Subsequent to the CEARP inspection, the U.S. Environmental Protection Agency, (EPA) conducted a RCRA Facility Assessment (RFA) (EPA April 1987). SWMU 85 was identified as SWMU 125 in the resulting document, which reiterated the findings of the CEARP Investigation. Conclusions in the RFA were as follows:

- A high potential existed for release to the air, soil, and surface water
- A low potential existed for release to groundwater
- A low potential existed for subsurface gas generation.

10.4.2.2 Sampling Data Collection

No samples were collected as part of the CEARP Investigation.

10.4.2.3 Data Gaps

No data were available to confirm whether hazardous or radioactive materials or wastes were disposed of or released to the surrounding environment.

10.4.2.4 Results and Conclusions

The CEARP findings for SWMU 85 were positive for RCRA-regulated hazardous waste, and the site was assigned a Hazardous Ranking Score of 4.1.

10.4.3 Investigation #2—SNL/ER Preliminary Investigations

10.4.3.1 Nonsampling Data Collection

This section describes the nonsampling investigation data collected at SWMU 85.

10.4.3.1.1 Background Review

A background review was conducted in order to collect available and relevant information regarding SWMU 85. Background information sources included interviews with SNL/NM staff and contractors familiar with the site's operational history and existing historical site records and reports. The study was documented completely and has provided traceable references that sustain the integrity of the NFA proposal. The following lists the information sources that were used to assist in the evaluation of SWMU 85 and referenced in Section 10.2.2, Operational History of this chapter.

- Field notes from site inspections conducted at the site by SNL/NM ER staff (Gaither September 1991)

- SNL/NM Facilities Engineering building drawings (SNL/NM August 1982, SNL/NM Date [unk]b)

- Seven interviews with nine facility personnel (current and retired) (Young and Wrightson April 1995, Perkins December 1984, Martz September 1985, Martz October 1985a, Martz October 1985b, Author [unk] Date [unk], Young January 1996)

- Memos from personnel describing activities at the SWMU (Marshall September 1993)

10.4.3.1.2 UXO/HE Survey

In February 1994, SNL/NM ER personnel and Kirtland Air Force Base Explosive Ordnance Unit performed a 100-percent coverage UXO survey at SWMU 85 (and SWMU 14). The survey visually inspected for ordnance, HE, and ordnance debris. No ordnance material was found at SWMU 85. (SNL/NM September 1994).

10.4.3.1.3 Radiological Survey(s)

The Phase I survey at SWMU 85 (and SWMU 14) was conducted during March 1994, and encompassed a total of 1.4 acres of flat graded terrain (RUST Geotech Inc. December 1994). An additional survey, conducted at Firing Site 4 in March 1996, covered 13.2 acres (SNL/NM September 1997). A gamma scan survey was performed at 6-foot centers (100-percent coverage) over the surface of the sites. Only one source area of gamma activity at 30 percent or greater than the natural background was identified during this survey. The one area source at SWMU 85 (and SWMU 14) was remediated based upon gamma spectroscopy results from the precleanup samples that showed that the elevated radiation was related to anthropogenic material. Cleanup of the source was completed in July 1995. Two point sources were identified at Firing Site 4, the Cable Suspension Facility. These were removed in June 1996 (SNL/NM September 1997). After removal of radiological contaminated soils, postcleanup (verification) samples were collected from SWMU 85. The samples were collected from areas exhibiting the highest residual gamma readings. Figure 10.4.3-1 shows confirmatory sample locations for the postcleanup samples and Section 10.4.4 discusses results.

10.4.3.1.4 Cultural-Resources Survey

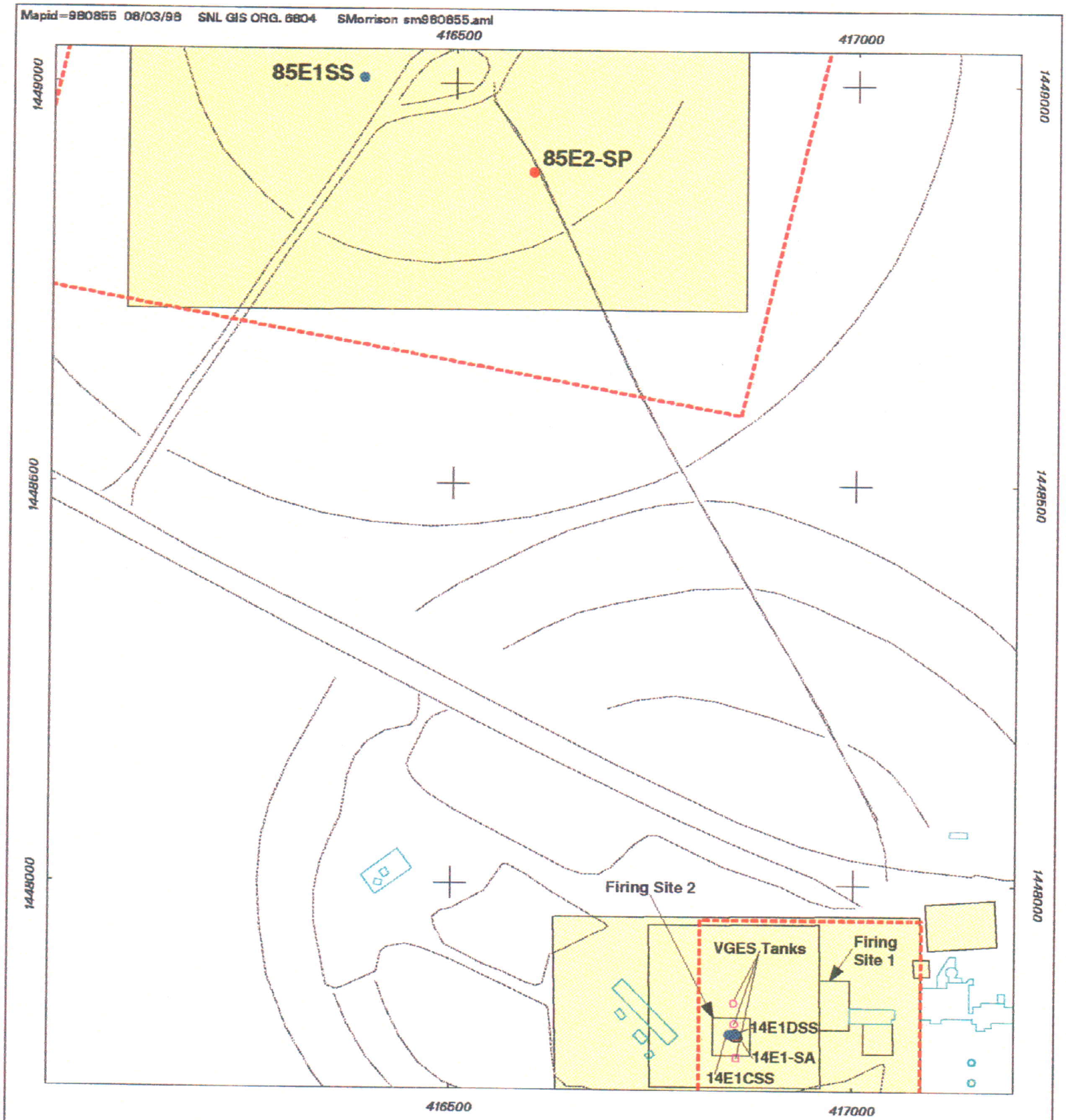
A cultural resources survey of SWMU 85 was conducted in 1994 in support of the environmental assessment of the SNL/NM ER Project (DOE March 1996). No cultural resources were present on the site (Hoagland and Dello-Russo February 1995).

10.4.3.1.5 Sensitive-Species Survey

A sensitive-species survey was performed at SWMU 85 in 1994. Findings from this survey indicate that no sensitive species are present on the site (DOE March 1996).

10.4.3.1.6 Geophysical Survey(s)

On March 5, 1997, MDM/Lamb Inc. conducted a geophysical investigation of SWMU 85 (Hyndman April 1997) at Firing Site 1, to locate potential subsurface test sites. The survey was



Legend

Point Source Gamma Radiation Anomaly (Elevated relative to site specific background SP = Soil Point)

Post-cleanup (Verification) Soil Sample Location (SS = Soil Sample)

Road

Building

Rad Survey Boundary

ER Site 14/85 Burial Site/Firing Site

Area Source Gamma Radiation Anomaly (Elevated relative to site specific background, SA = Soil Area)

0 100 200 Scale in Feet

0 24 48 Scale in Meters

1:2400

1 in=200'

Figure 10.4.3-1
VCM Radiation Anomalies and Surface Soil Sampling Locations at SWMU 85

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

conducted using a Geonics EM-61 high-precision locator for metal detection and a Geonics EM-38 ground conductivity meter to delineate changes in the soil characteristics that would indicate disturb soils (burial pits). Figures 10.4.3-2 and 10.4.3-3 show maps of the survey area and significant anomalies. Except for anomalies from underground utilities, no other anomalies were delineated indicating subsurface burial.

10.4.3.2 Sampling Data Collection

From July 28, 1995, through July 31, 1995, five boreholes in Firing Site 1 (BH-1, BH-2, BH-3, BH-4 and BH-5) were sampled at 5-foot intervals to a total depth of 17 feet. Figure 10.4.3-4 shows the locations at which the boreholes were sampled. A total of 20 samples were collected from the boreholes, excluding duplicates. The purpose of this screening sampling effort was to obtain preliminary analytical data to support the ER Project site ranking and prioritization. Other than duplicate samples for offsite laboratory analyses, no quality assurance (QA)/quality control (QC) samples were collected. The soils were analyzed for RCRA metals plus beryllium and nickel (see Table 10.4.3-1); gamma radiation (Table 10.4.3-2); and HE (Table 10.4.3-3). The samples were analyzed at SNL/NM's on-site laboratory, and 10 percent of the replicate samples were sent off site.

Based upon screening sample data there appears to be no gross metal contamination at SWMU 85. Concentrations of silver, nickel, barium, and lead exceeded the approved background levels. The maximum silver levels were detected at 13 milligrams (mg)/kg J (nonquantified background level is <1 mg/kg), arsenic was detected at 4.5 mg/kg (4.4 mg/kg is background level). The maximum nickel concentration was detected at 26 mg/kg (11.5 mg/kg is background), the maximum lead concentration was detected at 110 mg/kg (11.8 mg/kg background). All other metals were either below background levels or were not detected. On-site laboratory detection levels for silver, arsenic, cadmium, and selenium were above background limits or the nonquantified background levels (cadmium, selenium, and silver); however, these metals were not COCs at this site, but because of their detection limits greater than background, they are evaluated in the risk assessment (see Section 10.6).

All HE were below detection limits. Because explosives are not naturally occurring, there are no background values for these constituents.

When gamma radiation activities were compared to background for the significant COCs (uranium-238, uranium-235, and cesium-137), all activities were either below background levels or below the minimum detection activities (MDA) for each radionuclide. The MDA for some analytes, however, were above background levels. For thorium-232, all results were either below background or were not detected (i.e., less than MDA) and the MDAs were less than background levels. It appears from these screening results that there is no significant radiological contamination at Firing Site 1 at SWMU 85.

10.4.3.3 Data Gaps

Although the screening samples did not reveal any significant contamination at Firing Site 1, due to budget and time constraints, Firing Sites 2, 3, and 4 were not investigated during this phase. Additional data were needed to determine whether these areas were contaminated or not. Also, the preliminary data collected to date were not of adequate quality to characterize the

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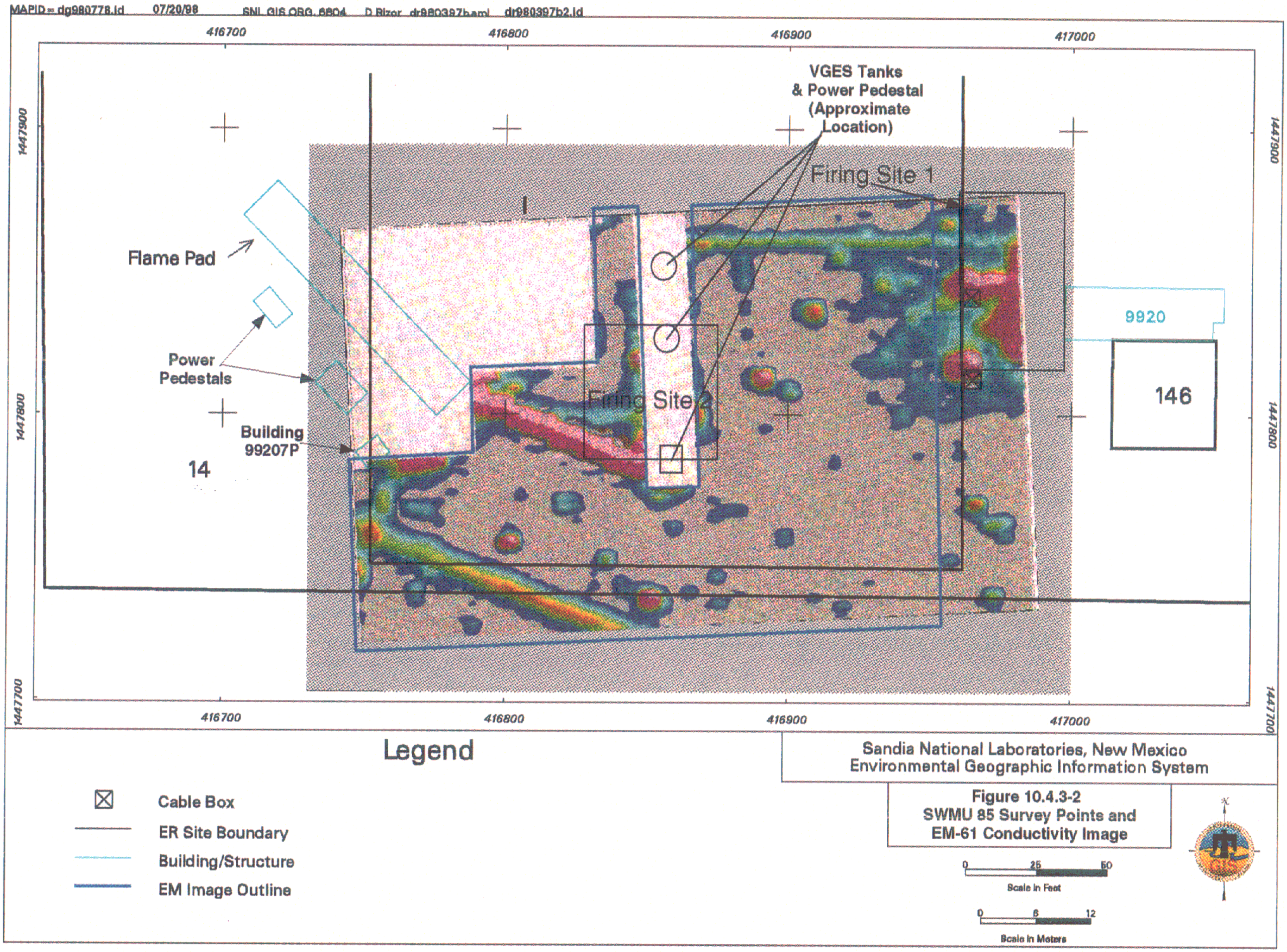


Figure 10.4.3-2
SWMU 85 Survey Points and
EM-61 Conductivity Image

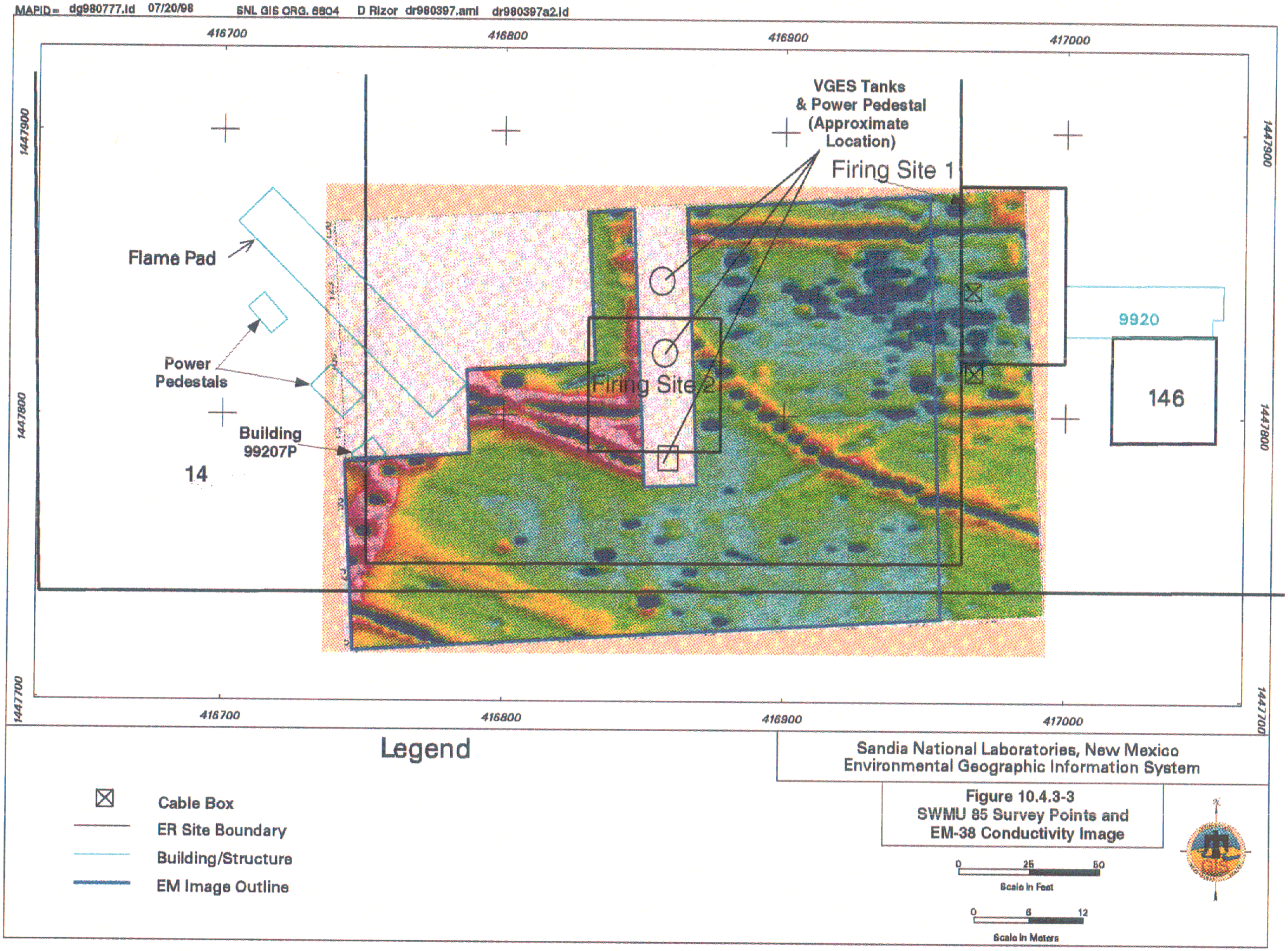


Figure 10.4.3-3
SWMU 85 Survey Points and
EM-38 Conductivity Image

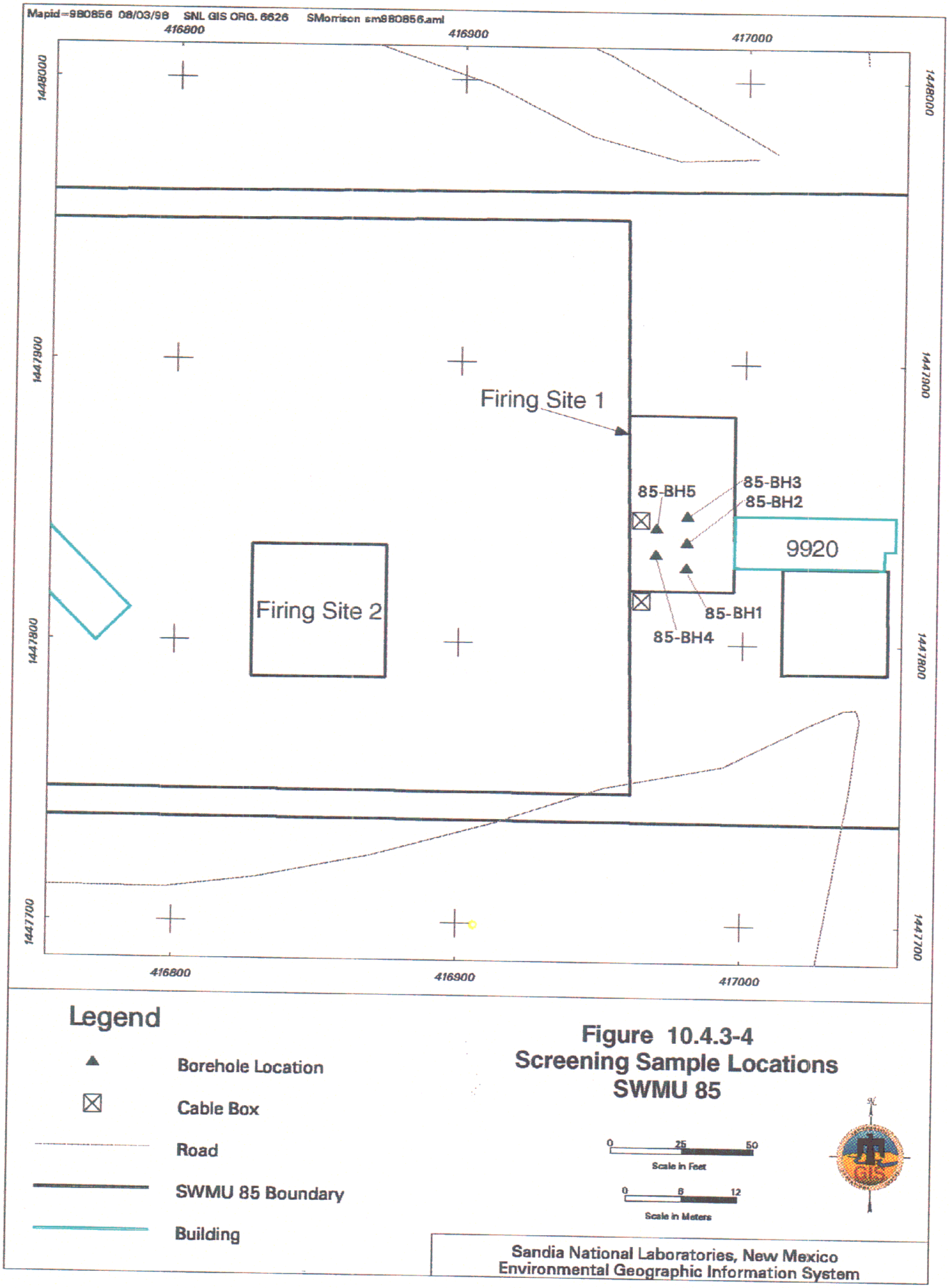


Figure 10.4.3-4
Screening Sample Locations
SWMU 85

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 10.4.3-1
Summary of SWMU 85 Screening Soil Sampling Metals Analytical Results, July 1995

Sample Attributes			Metals (EPA 6010/7000)[a] (mg/kg)									
Record Number[b]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
Firing Site 1												
509436	85-BH1-0-S-2	0	ND (50)	67	0.19 J (0.53)	ND (10)	ND (10)	**43**	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509436	85-BH1-05-S-2	5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509436	85-BH1-10-S-2	10	ND (50)	**580**[c]	0.17 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509436	85-BH1-15-S-2	15	ND (50)	81	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH2-0-S-2	0	ND (50)	76	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
3982	85-BH2-0-S-2	0	ND (2.0)[d]	**170**	ND (1.0)[d]	ND (1.0)[d]	6.6	**110**	ND (0.10)[d]	ND (8.1)[d]	ND (1.0)[d]	ND (2.0)[d]
509442	85-BH2-05-S-2	5	ND (50)	97	0.22 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH2-10-S-2	10	ND (50)	77	0.24 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH2-15-S-2	15	ND (50)	110	0.33 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH3-0-SD-2	0	ND (50)	74	0.18 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH3-05-S-2	5	ND (50)	140	ND (0.11)	ND (10)	ND (10)	**26 J (38)**	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH3-05-SD-2	5	ND (50)	82	ND (0.11)	ND (10)	ND (10)	**13 J (38)**	ND (0.06)	ND (4.0)	ND (50)	ND (10)
3982	85-BH3-5-S-2	5	4.4	**220**	ND (1.1)	ND (1.1)[d]	11	**25**	ND (0.11)[d]	9.5	ND (1.1)[d]	ND (2.3)[d]
509442	85-BH3-10-S-2	10	ND (50)	64	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH3-15-S-2	15	ND (50)	210	0.24 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH4-0-S-2	0	ND (50)	44	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH4-05-S-2	5	ND (50)	57	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH4-10-S-2	10	ND (50)	65	0.24 J (0.53)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
3982	85-BH4-10-S-2	10	3.2	150	ND (1.1)[d]	ND (1.1)[d]	10	9.0	ND (0.11)[d]	**26**	ND (1.1)[d]	ND (2.2)[d]
509442	85-BH4-15-S-2	15	ND (50)	35 J (38)	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH5-0-S-2	0	ND (50)	74	0.18 J (0.53)	ND (10)	ND (10)	**78**	ND (0.06)	ND (4.0)	ND (50)	13 J (38)
509442	85-BH5-05-S-2	5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH5-10-S-2	10	ND (50)	59	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH5-15-S-2	15	ND (50)	110	ND (0.11)	ND (10)	ND (10)	15 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509442	85-BH5-15-SD-2	15	ND (50)	76	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
3982	85-BH5-15-S-2	15	**4.5**	93	ND (1.1)[d]	ND (1.1)[d]	12	6.6	ND (0.11)[d]	12	ND (1.1)[d]	ND (2.1)[d]
3982	85-BH5-15-SD-2	15	3.1	180	ND (1.1)[d]	ND (1.1)[d]	11	7.5	ND (0.10)[d]	12	ND (1.1)[d]	ND (2.1)[d]

Refer to footnotes at end of table.

Table 10.4.3-1 (Concluded)
Summary of SWMU 85 Screening Soil Sampling Metals Analytical Results, July 1995

Sample Attributes			Metals (EPA 6010/7000)[a] (mg/kg)									
Record Number[b]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
Quality Assurance/Quality Control Sample (in mg/L)												
3982	85-BH5-15-EB-2 (equipment blank)	NA	ND (0.010)[d]	ND (0.20)[d]	ND (0.0050)[d]	ND (0.0050)[d]	ND (0.010)[d]	0.0037	ND (0.00020)[d]	ND (0.040)[d]	ND (0.0050)[d]	ND (0.010)[d]
3982	85-BH5-15-FB-2 (field blank)	NA	ND (0.010)[d]	ND (0.20)[d]	ND (0.0050)[d]	ND (0.0050)[d]	ND (0.010)[d]	ND (0.0030)[d]	ND (0.00020)[d]	ND (0.040)[d]	ND (0.0050)[d]	ND (0.010)[d]
509442	85-BH5-15-EB-2 (equipment blank)	NA	ND (0.50)	ND (0.10)	ND (0.034)	ND (0.10)	ND (0.10)	ND (0.10)	NT	ND (0.04)	ND (0.50)	ND (0.10)
509442	85-BH5-15-FB-2 (field blank)	NA	ND (0.50)	ND (0.10)	ND (0.034)	ND (0.10)	ND (0.10)	ND (0.10)	NT	ND (0.04)	ND (0.50)	ND (0.10)
Approved SNL/NM SWTA Surface/Subsurface Background Soil Concentrations[e]			5.6/4.4	130/214	0.65/0.65	<1/0.9	17.3/15.9	21.4/11.8	<0.25/<0.1	11.5/11.5	<1/<1	<1/<1

[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]Bold indicates those detected values are greater than NMED-approved quantified background values.
[d]( ) = not detected above the project reporting limit, shown in parenthesis.
[e]From Dinwiddie September 1997.

BH = Borehole.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit for on-site laboratory analysis or the required detection limit for off-site laboratory analyses, shown in parenthesis.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
NT = Not tested.
SNL/NM = Sandia National Laboratories/New Mexico.
S = Soil sample.
SD = Soil sample duplicate.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.

Table 10.4.3-2
Summary of SWMU 85 Screening Soil Sampling Gamma Spectroscopy Analytical Results, July 1995

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
Firing Site 1										
509-4	85-BH1-0-S-1	0	ND (2.51)	--	5.83E-01	2.87E-01	ND (4.75E-01)	--	ND (8.85E-02)	--
509-4	85-BH1-5-S-1	5	ND (2.12)	--	6.03E-01	2.39E-01	ND (4.11E-01)	--	ND (6.30E-02)	--
509-4	85-BH1-10-S-1	10	7.18E-01	1.74E-01	6.14E-01	2.20E-01	ND (4.12E-01)	--	ND (6.57E-02)	--
509-4	85-BH1-15-S-1	15	ND (2.00)	--	4.88E-01	2.01E-01	ND (3.57E-01)	--	ND (5.94E-02)	--
509408	85-BH2-0-S-1	0	ND (6.48)	--	6.07E-01	2.83E-01	ND (4.92E-01)	--	4.27E-02	3.17E-02
3941	85-BH2-0-S-1	0	ND (1.43)	--	5.22E-01	1.61E-01	ND (1.84E-01)	--	ND (3.91E-02)	--
509408	85-BH2-5-S-1	5	ND (4.59)	--	4.47E-01	1.82E-01	ND (3.51E-01)	--	ND (5.25E-02)	--
509408	85-BH2-10-S-1	10	ND (5.23)	--	5.61E-01	2.27E-01	ND (3.62E-01)	--	ND (5.35E-02)	--
509408	85-BH2-15-S-1	15	ND (6.27)	--	9.16E-01	3.54E-01	ND (4.35E-01)	--	ND (6.25E-02)	--
509408	85-BH3-0-S-1	0	ND (5.53)	--	4.36E-01	1.93E-01	ND (3.94E-01)	--	ND (5.93E-02)	--
509408	85-BH3-5-S-1	5	ND (6.24)	--	4.05E-01	2.60E-01	ND (4.35E-01)	--	ND (6.16E-02)	--
509408	85-BH3-5-SD-1	5	ND (6.41)	--	3.35E-01	2.39E-01	ND (4.42E-01)	--	2.21E-02	2.61E-02
3941	85-BH3-5-S-1	5	ND (1.44)	--	6.71E-01	1.69E-01	ND (1.79E-01)	--	2.25E-02	1.47E-02
509408	85-BH3-10-S-1	10	ND (5.55)	--	4.79E-01	2.04E-01	ND (3.98E-01)	--	ND (5.90E-02)	--
509408	85-BH3-15-S-1	15	ND (5.62)	--	7.89E-01	3.26E-01	ND (4.26E-01)	--	ND (5.93E-02)	--
509408	85-BH4-0-S-1	0	ND (5.14)	--	4.88E-01	1.99E-01	ND (3.66E-01)	--	4.67E-02	2.66E-02
509408	85-BH4-5-S-1	5	ND (5.37)	--	5.00E-01	2.11E-01	ND (3.66E-01)	--	ND (5.62E-02)	--
509408	85-BH4-10-S-1	10	ND (5.80)	--	4.97E-01	2.33E-01	ND (4.31E-01)	--	ND (6.58E-02)	--
3941	85-BH4-10-S-1	10	ND (1.55)	--	5.43E-01	1.73E-01	ND (1.92E-01)	--	ND (3.65E-02)	--
509408	85-BH4-15-S-1	15	ND (6.13)	--	6.96E-01	2.33E-01	ND (4.36E-01)	--	ND (6.29E-02)	--
509408	85-BH5-0-S-1	0	ND (6.18)	--	7.15E-01	2.26E-01	ND (4.23E-01)	--	ND (6.99E-02)	--
509408	85-BH5-5-S-1	5	ND (5.09)	--	4.33E-01	1.92E-01	ND (3.64E-01)	--	ND (5.74E-02)	--
509408	85-BH5-10-S-1	10	ND (5.28)	--	5.83E-01	2.87E-01	ND (3.85E-01)	--	ND (6.16E-02)	--
509408	85-BH5-15-S-1	15	ND (6.59)	--	8.45E-01	3.54E-01	ND (5.08E-01)	--	ND (7.84E-02)	--
509408	85-BH5-15-SD-1	15	ND (7.11)	--	6.93E-01	2.85E-01	ND (4.84E-01)	--	ND (7.19E-02)	--
3941	85-BH5-15-S-1	15	6.61E-01	5.72E-01	6.11E-01	1.71E-01	ND (2.17E-01)	--	ND (3.95E-02)	--
3941	85-BH5-15-SD-1	15	ND (1.53)	--	7.18E-01	1.92E-01	ND (1.86E-01)	--	ND (3.68E-02)	--
Quality Assurance/Quality Control Sample (pCi/L)										
3941	85-BH5-15-EB-1 (equipment blank)	NA	ND (6.51E-01)	--	ND (1.07E-01)	--	ND (8.59E-02)	--	ND (1.81E-02)	--
3941	85-BH5-15-FB-1 (field blank)	NA	ND (6.86E-01)	--	ND (1.08E-01)	--	ND (8.77E-02)	--	ND (2.04E-02)	--

Refer to footnotes at end of table.

Table 10.4.3-2 (Concluded)
Summary of SWMU 85 Screening Soil Sampling Gamma Spectroscopy Analytical Results, July 1995

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
			Uranium-238		Thorium-232		Uranium-235		Cesium-137	
Record Number[a]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
509408	85-BH5-15-FB-1 (field blank)	NA	ND (1.56)	--	ND (1.14E-01)	--	ND (1.46E-01)	--	ND (2.18E-02)	--
509408	85-BH5-15-EB-1 (equipment blank)	NA	ND (1.59)	--	ND (1.28E-01)	--	ND (1.48E-01)	--	ND (2.09E-02)	--
Approved SNL/NM SWTA Surface/Subsurface Background Soil Concentrations[c]			1.4/1.4	NA	1.01/1.01	NA	0.16/0.16	NA	0.664/0.079	NA

[a]Analysis request/chain of custody record.
[b]Two standard deviation about the mean detected activity.
[c]From Dinwiddie September 1997.

BH = Borehole.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected at or above the minimum detectable activity, shown in parenthesis.
NT = Not tested.
pCi/g = Picocurie(s) per gram.
pCi/L = Picocurie(s) per liter.
S = Soil sample.
SD = Soil sample duplicate.
SNL/NM = Sandia National Laboratories/New Mexico.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.
-- = Error not calculated for nondetected results.

Table 10.4.3-3
Summary of SWMU 85 Screening Soil Sampling HE Analytical Results, July 1995

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)							
Record Number[b]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino, 4,6-dinitrotoluene	4-Amino, 2,6-dinitrotoluene	o-Nitrotoluene (2)	m-Nitrotoluene (3)	p-Nitrotoluene (4)
Firing Site 1										
509439	85-BH1-0-S-3	0	ND (76)	NT	NT	NT	NT	NT	NT	NT
509439	85-BH1-5-S-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509439	85-BH1-10-S-3	10	ND (76)	NT	NT	NT	NT	NT	NT	NT
509439	85-BH1-15-S-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH2-0-S-3	0	ND (76)	NT	NT	NT	NT	NT	NT	NT
3982	85-BH2-0-S-3	0	ND (250)[c]	ND (260)[c]	ND (250)[c]	ND (250)[c]	ND (250)[c]	ND (250)[c]	ND (250)[c]	ND (250)[c]
509441	85-BH2-5-S-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH2-10-S-3	10	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH2-15-S-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH3-0-S-3	0	ND (76)	NT	NT	NT	NT	NT	NT	NT
3982	85-BH3-5-S-3	5	ND (280)[c]	ND (290)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]
509441	85-BH3-5-S-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH3-5-SD-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH3-10-S-3	10	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH3-15-S-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH4-0-S-3	0	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH4-5-S-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH4-10-S-3	10	ND (76)	NT	NT	NT	NT	NT	NT	NT
3982	85-BH4-10-S-3	10	ND (280)[c]	ND (290)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]
509441	85-BH4-15-S-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-0-S-3	0	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-5-S-3	5	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-10-S-3	10	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-15-S-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-15-SD-3	15	ND (76)	NT	NT	NT	NT	NT	NT	NT
3982	85-BH5-15-S-3	15	ND (280)[c]	ND (290)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]
3982	85-BH5-15-SD-3	15	ND (280)[c]	ND (290)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]	ND (280)[c]
Quality Assurance/Quality Control Sample (µg/L [water])										
3982	BH5-15-EB-3 (equipment blank)	NA	ND (0.26)[c] H	ND (0.26)[c] H	ND (0.25)[c] H	ND (0.26)[c] H	ND (0.26)[c] H	ND (0.25)[c] H	ND (0.25)[c] H	ND (0.25)[c] H
3982	BH5-15-FB-3 (field blank)	NA	ND (0.26)[c] H	ND (0.26)[c] H	ND (0.25)[c] H	ND (0.26)[c] H	ND (0.26)[c] H	ND (0.25)[c] H	ND (0.25)[c] H	ND (0.25)[c] H
509441	85-BH5-15-EB-3 (equipment blank)	NA	ND (76)	NT	NT	NT	NT	NT	NT	NT
509441	85-BH5-15-FB-3 (field blank)	NA	ND (76)	NT	NT	NT	NT	NT	NT	NT

Refer to footnotes at end of table.

Table 10.4.3-3 (Concluded)
Summary of SWMU 85 Screening Soil Sampling HE Analytical Results, July 1995

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)							
Record Number[b]	ER Sample ID (Figure 10.4.3-4)	Sample Depth (ft)	Nitrobenzene	1,3 Dinitrobenzene	1,3,5 Trinitrobenzene	PETN	NG	RDX	Tetryl	HMX
Firing Site 1										
509439	85-BH1-0-S-3	0	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509439	85-BH1-5-S-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509439	85-BH1-10-S-3	10	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509439	85-BH1-15-S-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH2-0-S-3	0	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
3982	85-BH2-0-S-3	0	ND (260)[c]	ND (250)[c]	ND (250)[c]	NT	NT	ND (1000)[c]	ND (650)[c]	ND (2200)[c]
509441	85-BH2-5-S-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH2-10-S-3	10	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH2-15-S-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH3-0-S-3	0	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
3982	85-BH3-5-S-3	5	ND (290)[c]	ND (280)[c]	ND (280)[c]	NT	NT	ND (1100)[c]	ND (720)[c]	ND (2400)[c]
509441	85-BH3-5-S-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH3-5-SD-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH3-10-S-3	10	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH3-15-S-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH4-0-S-3	0	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH4-5-S-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH4-10-S-3	10	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
3982	85-BH4-10-S-3	10	ND (290)[c]	ND (280)[c]	ND (280)[c]	NT	NT	ND (1100)[c]	ND (720)[c]	ND (2.400)[c]
509441	85-BH4-15-S-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-0-S-3	0	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-5-S-3	5	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-10-S-3	10	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-15-S-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-15-SD-3	15	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
3982	85-BH5-15-S-3	15	ND (290)[c]	ND (280)[c]	ND (280)[c]	NT	NT	ND (1100)[c]	ND (720)[c]	ND (2400)[c]
3982	85-BH5-15-SD-3	15	ND (290)[c]	ND (280)[c]	ND (280)[c]	NT	NT	ND (1100)[c]	ND (720)[c]	ND (2400)[c]
Quality Assurance/Quality Control Sample (µg/L [water])										
3982	BH5-15-EB-3 (equipment blank)	NA	ND (0.50)[c] H	ND (0.30)[c] H	ND (0.45)[c] H	NT	NT	ND (0.85)[c] H	ND (1.0)[c] H	ND (1.0)[c] H
3982	BH5-15-FB-3 (field blank)	NA	ND (0.50)[c] H	ND (0.30)[c] H	ND (0.45)[c] H	NT	NT	ND (0.85)[c] H	ND (1.0)[c] H	ND (1.0)[c] H
509441	85-BH5-15-EB-3 (equipment blank)	NA	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)
509441	85-BH5-15-FB-3 (field blank)	NA	NT	NT	NT	ND (150)	ND (30)	ND (150)	NT	ND (100)

[a] EPA November 1986.
[b] Analysis request/chain of custody record.
[c] Not detected above the practical quantitation limit, shown in parenthesis.

BH = Borehole.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
H = Holding time was exceeded.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
ID = Identification.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the method detection limit, shown in parenthesis.
NT = Not tested.
NG = Nitroglycerin.
PETN = 1,3-dinitrato-2,2-bis(nitratomethyl) propane.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
S = Soil sample.
SD = Soil sample duplicate.
TETRYL = 2,4,6-trinitrophenylmethylnitramine.

site fully. In some cases, the detection limits exceeded background levels. For these reasons, additional sampling was required to characterize the site fully.

10.4.3.4 Results and Conclusions

Preliminary investigations at SWMU 85 revealed no geophysical anomalies other than buried utility lines, and no significant contamination was detected in the screening activities.

10.4.4 Investigation #3—SNL/NM SWMU RFI Sampling

Initially, the RFI sampling plan called for collecting 20 random surface samples and a total of 10 subsurface samples from five boreholes west of the cable run boxes, if geophysics indicated subsurface anomalies. Based upon subsequent discussions with the New Mexico Environment Department (NMED), it was agreed to install two boreholes (BH-6 and BH-7) west of the cable run boxes, and one borehole (BH-8) immediately to the north of Firing Site 1 (SNL/NM June 1997). Additionally, 25 surface soil samples were collected from Firing Sites 1, 2, and 4. The sampling procedures and results are discussed in detail in the following sections.

10.4.4.1 Nonsampling Data Collection

Except for the geophysical survey discussed above, no additional nonsampling activities were implemented. However, SNL/NM conducted a survey on May 15, 1997, and on June 16, 1997, to confirm the presence and location of underground utilities detected in the geophysical survey.

10.4.4.2 Sampling Data Collection

10.4.4.2.1 Voluntary Corrective Measure Activities

Except for the radiological VCM activities performed by RUST-Geotech Inc. (Section 10.4.3.1.3), no VCM activities were conducted at SWMU 85.

10.4.4.2.2 Confirmatory Sampling

To determine whether any contamination existed at Firing Sites 2, 3, and 4, and to further characterize Firing Site 1, twenty-five surface samples were collected from the 0- to 6-inch depth, and nine subsurface samples were collected from three boreholes using the Geoprobe sampler at depths of 5 to 7, 10 to 12, and 15 to 17 feet, from September through October 1997. The samples were collected according to the procedures described in the SWMU 85 sampling plan (SNL/NM February 1996) bullets of understanding, June 11, 1997. In addition to the sample locations described in the SAP, three more surface samples were collected at Firing Site 4 in an area of discolored soils (Samples 85-4-GR-026, 85-4-GR-027, and 85-4-GR-028, four surface samples collected around the VGES tank at Firing Site 2 (85-1-GR-029, 85-1-GR-030, 85-1-GR-031, and 85-1-GR-032). All samples were collected using an approved SNL/NM field operating procedure. SNL/NM Department 7713 (Radiation Protection Sample Diagnostics Laboratory) analyzed all samples on site for gamma-emitting radionuclides using gamma spectroscopy (Annex 10-A). Chemical analyses (HE and RCRA metals plus nickel and beryllium) were performed by Lockheed Analytical Services of Las Vegas, Nevada, and General Engineering Laboratories of Charleston, South Carolina, at Level III data quality. Level III data are definitive data (including matrix spikes (MS), matrix spike duplicates (MSD), laboratory control samples (LCS), and laboratory control sample duplicates (LCSD) appropriate for site characterization. RCRA metals were analyzed using EPA Method 6010/7000 (EPA November 1986). HE were analyzed using EPA Method 8330 (EPA November 1986). Level III data were validated (Annex 10-B) as set forth by SNL/NM Technical Operating Procedure 94-03 (SNL/NM July 1994). Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3 show sample locations. Tables 10.4.4-1, 10.4.4-2, 10.4.4-3, and 10.4.4-4 show results.

10.4.4.3 Data Gaps

Because no data were available to prove or refute unequivocally the presence of contamination at SWMU 85, the sampling plan was designed to determine whether the COCs were present, and if they were, the extent of the contamination.

10.4.4.4 Results and Conclusions

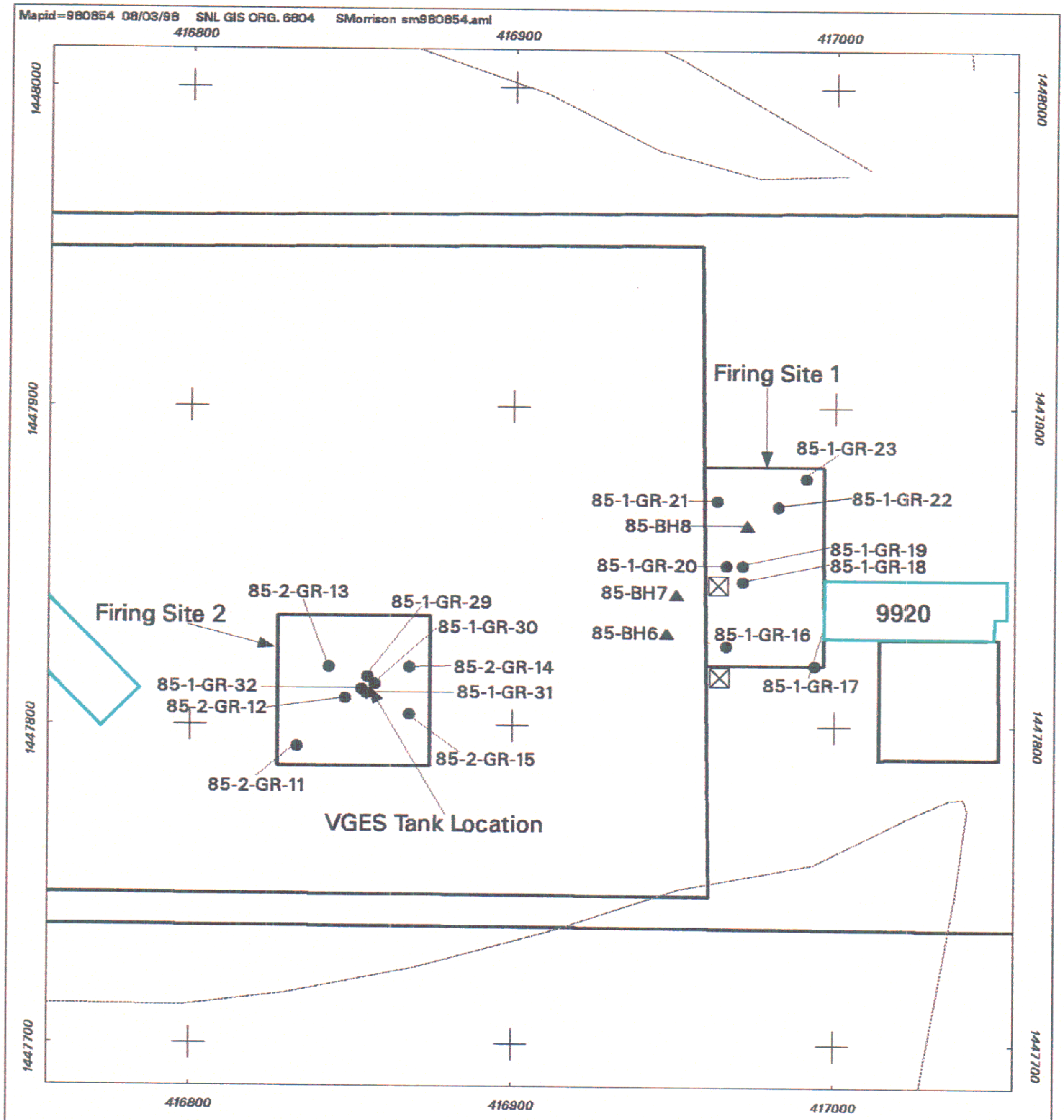
<u>Metals</u>

Five metals (beryllium, cadmium, selenium, mercury and silver) were below the approved background limits (beryllium) or the nonquantified background values (cadmium, selenium, mercury, and silver) established for the subsurface soils in the Southwest Test Area (SWTA). However, the maximum detection limit for mercury (0.11 mg/kg), slightly exceeded the unquantified background value of <0.1 mg/kg.

All subsurface concentrations for chromium and lead were either not detected or were below background. Some concentrations of chromium and lead in surface soils exceeded background. Only one chromium sample, at 23 mg/kg, exceeded the background level of 17.3 mg/kg. Eight surface samples exceeded the approved background value of 21.4 mg/kg for lead. The maximum concentration for lead detected in the confirmatory samples was 380 mg/kg.

Arsenic and nickel were both below approved background limits in surface soils. In subsurface soils, each COC exceeded background limits in only one sample. The arsenic concentration in the subsurface soils was 4.6 mg/kg (background is 4.4 mg/kg) and the maximum nickel concentration was 38 mg/kg kg (background is 11.5 mg/kg).

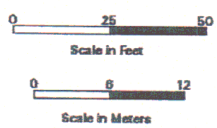
Barium was present above background limits in both surface and subsurface soils. Eight surface soil samples were above approved the approved background limits of 130 mg/kg. The maximum barium value in surface soils was 400 mg/kg. Seven of the samples were from Firing Site 1 and one sample was from Firing Site 4. The barium concentration for one subsurface sample (85-BH-008-5.0-S) was 370 mg/kg (background is 214 mg/kg).



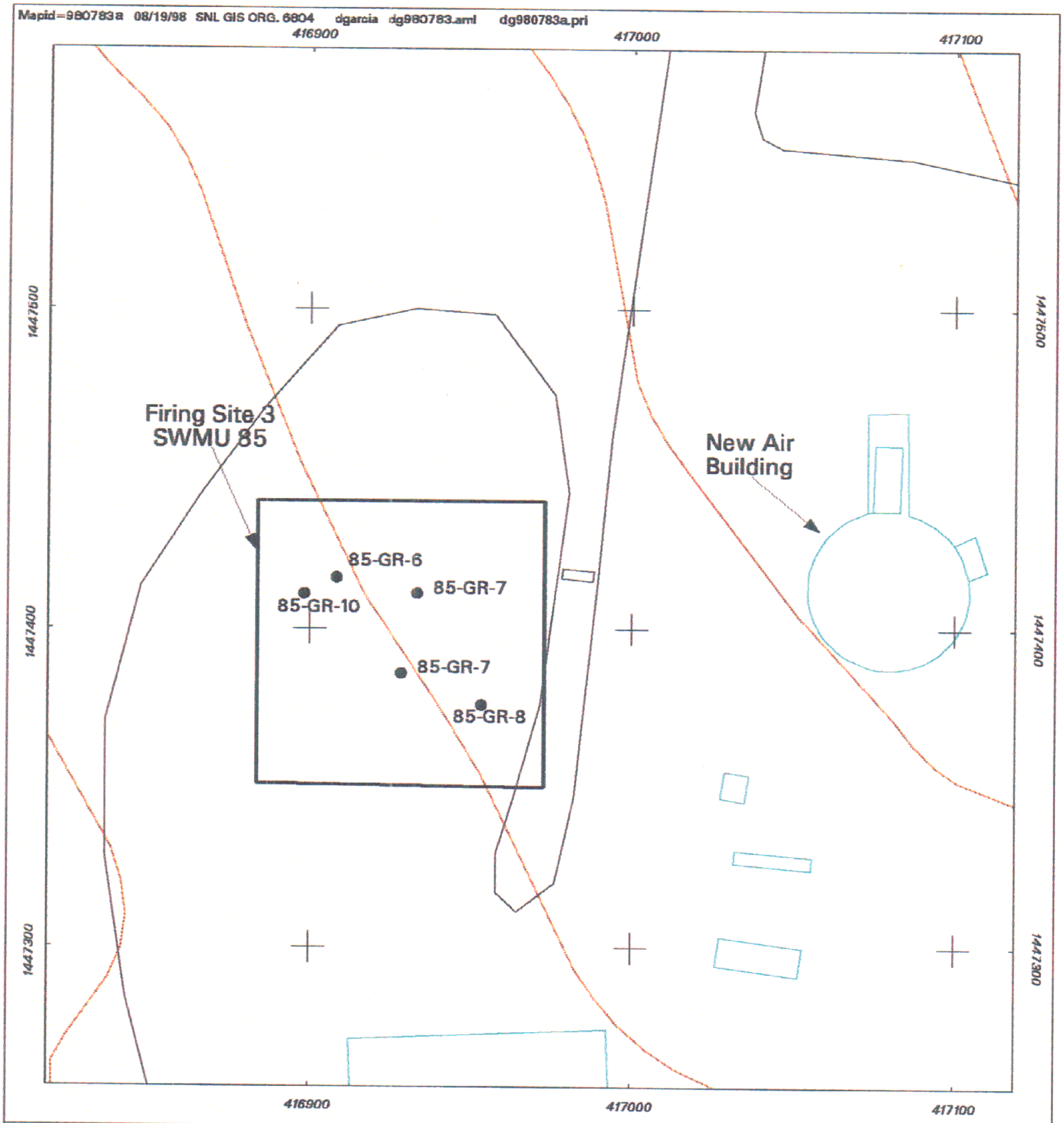
Legend

- ● Surface Sample
- ▲ Borehole Location
- ⊠ Cable Box
- Road
- SWMU 85 Boundary
- Building

Figure 10.4.4-1
SWMU 85
Confirmatory Sample Locations
Firing Sites 1& 2



Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

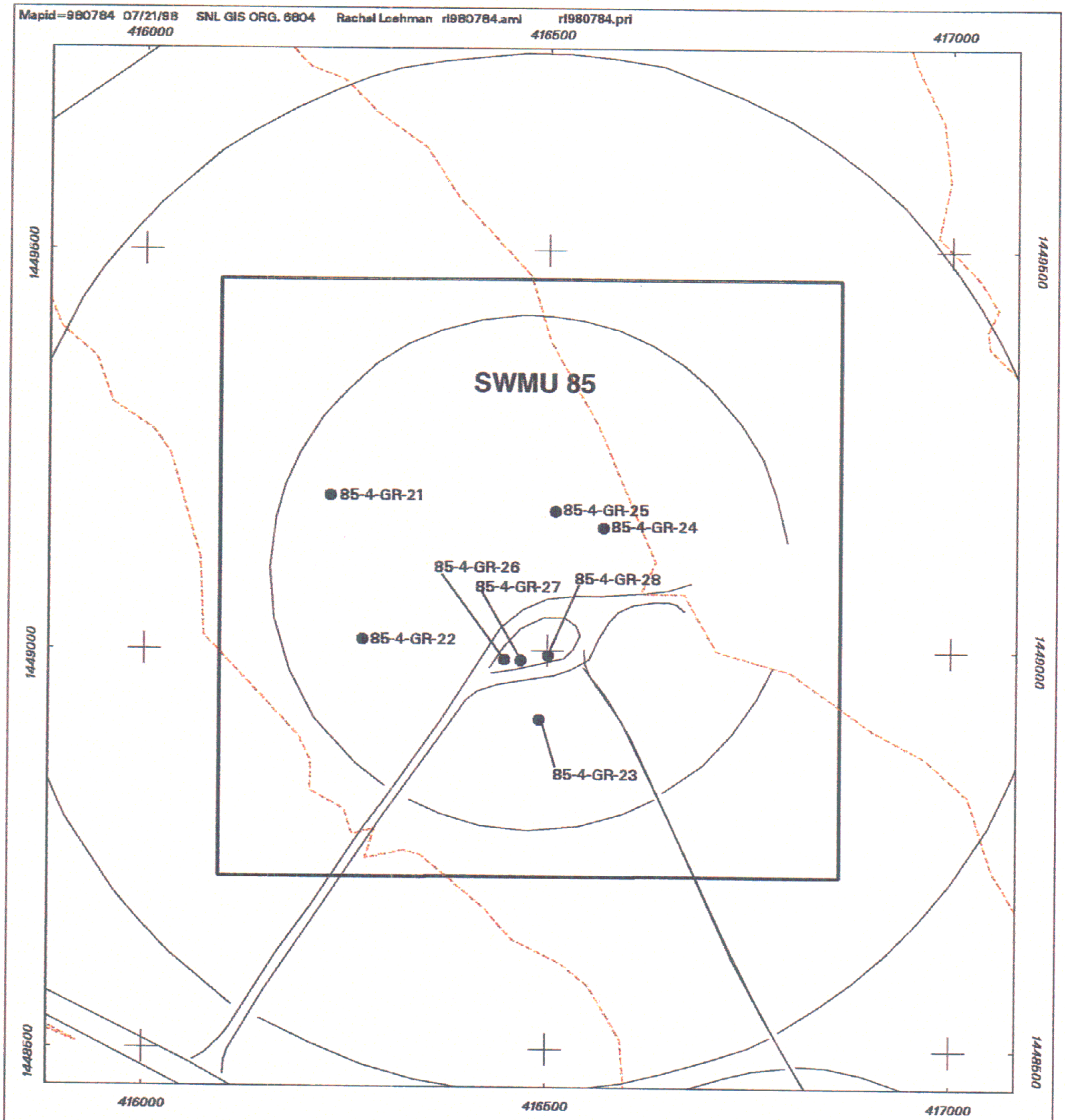
- Soil Sample Location
- Road
- 2 Foot Contour
- Building
- SWMU 85

Figure 10.4.4-2
Soil Sampling Locations at SWMU 85, Firing Site 3

0 25 50
Scale in Feet

0 6 12
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

- Sample Location
- Road
- 10 Foot Contour
- SWMU 85

Figure 10.4.4-3
SWMU 85
Confirmation Sample Locations
Firing Site 4

0 100 200
Scale in Feet

0 24 48
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 10.4.4-1
Summary of SWMU 85 Confirmatory Soil Sampling Metals Analytical Results, April—October 1997

Sample Attributes			Metals (EPA 6010/7000)[a] (mg/kg)									
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
Firing Site 1												
6354	85-BH-006-0.0-S	0	2.7	**260**[c]	0.43 J (0.52)	0.16 J (0.52)	7.4	**51**	ND (0.10)	7.2	0.47 J (0.52)	0.12 J (1.0)
6354	85-BH-006-0.0-SD	0	2.3	**290**	0.44 J (0.52)	0.16 J (0.52)	9.0	**50**	ND (0.099)	7.4	0.53	0.12 J (1.0)
6354	85-BH-006-5.0-S	5	2.6	120	0.35 J (0.52)	ND (0.11)	7.9	6.9	ND (0.11)	38	ND (0.32)	ND (0.11)
6354	85-BH-006-10.0-S	10	4.6	110	0.47 J (0.53)	ND (0.11)	9.2	6.0	ND (0.11)	7.9	ND (0.32)	ND (0.11)
6354	85-BH-006-15.0-S	15	3.5	200	0.51 J (0.54)	ND (0.11)	10	6.7	ND (0.11)	10	0.34 J (0.54)	ND (0.11)
6354	85-BH-007-0.0-S	0	2.5	**230**	0.45 J (0.52)	0.10 J (0.52)	9.4 J	16	ND (0.10)	6.8	0.41 J (0.54)	ND (0.10)
6354	85-BH-007-0.0-SD	0	1.8	**160**	0.33 J (0.52)	0.12 J (0.52)	6.2 J	12	ND (0.10)	6.6	ND (0.31)	ND (0.10)
6354	85-BH-007-5.0-S	5	2.7	120	0.40 J (0.53)	ND (0.11)	7.0 J	4.6	ND (0.10)	6.6	ND (0.32)	ND (0.11)
6354	85-BH-007-10.0-S	10	3.6	59	0.43 J (0.53)	ND (0.11)	9.6 J	6.2	ND (0.11)	7.8	ND (0.32)	ND (0.11)
6354	85-BH-007-15-S	15	3.2	170	0.45 J (0.54)	ND (0.11)	9.2 J	6.5	ND (0.11)	9.2	ND (0.32)	ND (0.11)
6354	85-BH-008-0.0-S	0	2.2	74	0.43 J (0.53)	ND (0.11)	23 J	9.3	ND (0.11)	7.3	0.51 J (0.53)	ND (0.11)
6354	85-BH-008-0.0-SD	0	2.6	79	0.42 J (0.53)	0.12 J (0.53)	8.3 J	8.8	ND (0.11)	6.7	ND (0.32)	ND (0.11)
6354	85-BH-008-5.0-S	5	3.5	**370**	0.47 J (0.53)	0.11 J (0.53)	12 J	6.0	ND (0.11)	8.7	ND (0.32)	ND (0.11)
6354	85-BH-008-10.0-S	10	4.1	200	0.53 J (0.53)	ND (0.11)	8.8 J	6.7	ND (0.10)	9.5	0.38 J (0.53)	ND (0.11)
6354	85-BH-008-15.0-S	15	3.1	110	0.47 J (0.53)	ND (0.11)	10 J	6.0	ND (0.11)	8.5	0.34 J (0.53)	ND (0.11)
6615	85-1-GR-016-00-SSO	0	2.5	**400**	NT	ND (0.21)	10	**95 PJ**	ND (0.11)	NT	ND (0.63)	ND (0.21)
6615	85-1-GR-017-00-SSO	0	2.2	**170**	NT	0.35 J (1.0)	6.4	**380 PJ**	ND (0.10)	NT	ND (0.62)	0.41 J (2.1)
6615	85-1-GR-018-00-SSO	0	2.6	**340**	NT	ND (0.21)	10	**260 PJ**	ND (0.10)	NT	0.81 J (1.0)	ND (0.20)
6615	85-1-GR-019-00-SSO	0	2.5	**170**	NT	ND (0.21)	6.1	**23 PJ**	ND (0.098)	NT	ND (0.62)	ND (0.20)
6615	85-1-GR-020-00-SSO	0	2.3	120	NT	ND (0.21)	7.5	**140 PJ**	ND (0.10)	NT	ND (0.62)	ND (0.20)
6615	85-1-GR-020-00-SSD	0	3.0	**130**	NT	ND (0.21)	7.1	**27 PJ**	ND (0.10)	NT	ND (0.63)	ND (0.21)
6615	85-1-GR-021-00-SSO	0	3.0	110	NT	ND (0.20)	7.8	6.3 PJ	ND (0.10)	NT	ND (0.61)	ND (0.20)
6615	85-1-GR-022-00-SSO	0	2.4	79	NT	ND (0.20)	5.8	17 PJ	ND (0.10)	NT	0.64 J (1.0)	ND (0.21)
6615	85-1-GR-023-00-SSO	0	3.3	110	NT	ND (0.21)	9.3	**93 PJ**	ND (0.10)	NT	ND (0.63)	ND (0.21)
Firing Site 2												
6615	85-2-GR-011-00-SSO	0	3.2	87	NT	ND (0.21)	17	9 PJ	ND (0.094)	NT	ND (0.62)	ND (0.19)
6615	85-2-GR-012-00-SSO	0	2.8	80	NT	ND (0.21)	16	15 PJ	ND (0.10)	NT	ND (0.63)	ND (0.20)
6615	85-2-GR-013-00-SSO	0	2.7	73	NT	ND (0.21)	9.8	14	ND (0.099)	NT	ND (0.63)	ND (0.20)
6615	85-2-GR-013-00-SSD	0	2.9	79	NT	ND (0.21)	9.9	13	ND (0.090)	NT	ND (0.62)	ND (0.21)
6615	85-2-GR-014-00-SSO	0	2.5	96	NT	ND (0.21)	13	18	ND (0.098)	NT	ND (0.62)	ND (0.21)
6615	85-2-GR-015-00-SSO	0	3.4	83	NT	ND (0.21)	10	9.1	ND (0.11)	NT	ND (0.64)	ND (0.21)

Refer to footnotes at end of table.

Table 10.4.4-1(Continued)
Summary of SWMU 85 Confirmatory Soil Sampling Metals Analytical Results, April—October 1997

Sample Attributes			Metals (EPA 6010/7000)[a] (mg/kg)									
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
6433	85-1-GR-029-0-SSO	0	2.14	78.2	0.393 J (0.490)	0.341 J (0.490)	7.31	13.2	ND (.0173)	7.12	0.255 J (0.490)	ND (.031)
6433	85-1-GR-030-0-SSO	0	1.80	59.9	0.307 J (0.500)	0.135 J (0.500)	5.33	9.33	0.0137 J (0.0259)	4.82	0.199 J (0.500)	ND (.031)
6433	85-1-GR-031-0-SSO	0	2.27	78.1	0.417 J (0.476)	0.0915 J (0.476)	6.79	30.8	ND (.0173)	6.38	ND (.07)	ND (.031)
6433	85-1-GR-032-0-SSO	0	2.39	108	0.419 J (0.485)	0.214 J (0.485)	8.24	13.8	ND (.0173)	7.65	ND (.07)	ND (.031)
6433	85-1-GR-032-0-SSD	0	2.46	108	0.436 J (0.495)	0.198 J (0.495)	10.5	20.3	ND (.0173)	7.87	ND (.07)	ND (.031)
Firing Site 3												
6614	85-GR-006-00-SS	0	3.94	86.5	0.583	0.399 J (0.472)	9.77	7.20	0.0165 J (0.0297)	8.93	0.648	0.890 J (0.943)
6614	85-GR-007-00-SS	0	2.02	64.7	0.381 J (0.459)	0.349 J (0.459)	6.00	5.26	ND (.0167)	6.76	0.44 J (0.459)	3.000
6614	85-GR-008-00-SS	0	1.75	52.3	0.334 J (0.485)	0.218 J (0.485)	5.07	4.58	ND (.0167)	5.03	0.255 J (0.485)	0.449 J (0.971)
6614	85-GR-009-00-SS	0	2.06	71.5	0.465 J (0.481)	0.373 J (0.481)	5.93	5.79	ND (.0167)	5.60	0.602	0.770 J (0.962)
6614	85-GR-010-00-SS	0	3.25	100	0.510	0.301 J (0.485)	7.28	6.06	ND (.0167)	6.68	0.333 J (0.485)	0.503 J (0.971)
6614	85-GR-010-00-SD	0	2.70	65.2	0.423 J (0.485)	0.279 J (0.485)	6.84	5.67	ND (.0167)	6.21	0.307 J (0.485)	0.575 J (0.971)
Firing Site 4												
6615	85-4-GR-021-00-SSO	0	2.9	57	NT	ND (0.20)	9.7	8.7	ND (0.093)	NT	ND (0.61)	ND (0.20)
6615	85-4-GR-022-00-SSO	0	3.7	72	NT	ND (0.21)	13	10	ND (0.094)	NT	0.76 J (1.0)	ND (0.21)
6615	85-4-GR-023-00-SSO	0	2.7	59	NT	ND (0.20)	7.8	8.2	ND (0.096)	NT	ND (0.59)	ND (0.20)
6615	85-4-GR-024-00-SSO	0	2.6	57	NT	ND (0.20)	8.7	8.2	ND (0.093)	NT	ND (0.60)	ND (0.20)
6615	85-4-GR-025-00-SSO	0	3.6	**160**	NT	ND (0.21)	9.1	5.9	ND (0.090)	NT	0.63 J (1.0)	ND (0.21)
6615	85-4-GR-026-00-SSO	0	2.7	52	NT	ND (0.20)	8.7	7.0	ND (0.087)	NT	ND (0.60)	ND (0.20)
6615	85-4-GR-027-00-SSO	0	2.4	52	NT	ND (0.20)	7.3	6.7	ND (0.087)	NT	ND (0.60)	ND (0.20)
6615	85-4-GR-028-00-SSO	0	2.9	61	NT	ND (0.21)	10	6.1	ND (0.098)	NT	ND (0.62)	ND (0.21)
6615	85-4-GR-028-00-SSD	0	2.6	63	NT	ND (0.21)	9.4	6.1	ND (0.095)	NT	ND (0.63)	ND (0.21)
Quality Assurance/Quality Control Sample (in mg/L)												
6354	85-1 BH-008-EB (equipment blank)	NA	ND (0.0030)	0.0029 J (0.20)	ND (0.0010)	ND (0.0010)	0.0045 J (0.010)	0.0026 J (0.0030)	ND (0.00020)	0.0033[c] J (0.040)	ND (0.0030)	ND (0.0010)
6614	85-GR-010-00-EB (equipment blank)	NA	ND (.00276)	0.000269 J (0.0100)	ND (.000135)	ND (.000209)	ND (.00621)	ND (.00136)	ND (.0001)	ND (.000996)	ND (.00228)	ND (.000424)
6615	85-4-GR-028-00-EB (equipment blank)	NA	ND (0.0030)	0.012 J (0.20)	NT	ND (0.0010)	0.0046 J (0.010)	0.049J B	ND (0.0020)	NT	ND (0.0030)	ND (0.0010)

Refer to footnotes at end of table.

Table 10.4.4-1 (Concluded)
Summary of SWMU 85 Confirmatory Soil Sampling Metals Analytical Results, April—October 1997

Sample Attributes			Metals (EPA 6010/7000)[a] (mg/kg)									
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
6433	85-1-GR-032-EB (equipment blank)	NA	ND (.00293)	ND (.000332)	ND (.000223)	ND (.000208)	ND (.000729)	ND (.000678)	0.000168 J (0.000200)	ND (.00227)	ND (.0014)	0.00218 J (0.00500)
Approved SNL/NM SWTA Surface/Subsurface Background Soil Concentrations[d]			5.6/4.4	130/214	0.65/0.65	<1/0.9	17.3/15.9	21.4/11.8	<0.25/<0.1	11.5/11.5	<1/<1	<1/<1

[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]Bold indicates these values are greater than NMED-approved quantified background values.
[d]From Dinwiddie September 1997.

B = Analyte detected in associated blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = The associated value is an estimated quantity.
J ( ) = The reported value is above the MDL but is less than the reporting limit or required detection limit, shown in parenthesis.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
NMED = New Mexico Environment Department.
NT = Not tested.
P = Laboratory precision measurements for the laboratory control sample and duplicate (LCS/LCSD) do not meet acceptance criteria.
SNL/NM = Sandia National Laboratories/New Mexico.
SD and SSD = Surface soil sample duplicate.
SS and SSO = Surface soil sample.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.

Table 10.4.4-2
Summary of SWMU 85 Confirmatory Soil Sampling HE Analytical Results, April—October 1997

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)							
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino, 4,6-dinitrotoluene	4-Amino, 2,6-dinitrotoluene	o-Nitrotoluene (2)	m-Nitrotoluene (3)	p-Nitrotoluene (4)
Firing Site 1										
6354	85-BH-006-0.0-S	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-006-0.0-SD	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-006-5.0-S	5	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-006-10.0-S	10	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-006-15.0-S	15	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-007-0.0-S	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-007-0.0-SD	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-007-5.0-S	5	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-007-10.0-S	10	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-007-15.0-S	15	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-008-0.0-S	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-008-0.0-SD	0	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-008-5.0-S	5	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-008-10.0-S	10	ND (110) AR	ND (160) AR	ND (190) AR	ND (130) AR	ND (55) AR	ND (70) AR	ND (160) AR	ND (170) AR
6354	85-BH-008-15.0-S	15	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-016-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-017-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-018-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-019-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-020-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-020-00-SSD	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-021-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-022-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-1-GR-023-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
Firing Site 2										
6615	85-2-GR-011-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-2-GR-012-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-2-GR-013-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-2-GR-013-00-SSD	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-2-GR-014-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-2-GR-015-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6433	85-1-GR-029-0-SSO	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
6433	85-1-GR-030-0-SSO	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)

Refer to footnotes at end of table.

Table 10.4.4-2 (Continued)
Summary of SWMU 85 Confirmatory Soil Sampling HE Analytical Results, April—October 1997

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)					
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Nitrobenzene	1,3 Dinitrobenzene	1,3,5 Trinitrobenzene	RDX	Tetryl	HMX
Firing Site 1								
6354	85-BH-006-0.0-S	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-006-0.0-SD	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-006-5.0-S	5	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-006-10.0-S	10	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-006-15.0-S	15	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-007-0.0-S	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-007-0.0-SD	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-007-5.0-S	5	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-007-10.0-S	10	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-007-15.0-S	15	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-008-0.0-S	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-008-0.0-SD	0	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-008-5.0-S	5	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-008-10.0-S	10	ND (150) AR	ND (100) AR	ND (70) AR	ND (190) AR	ND (340) AR	ND (420) AR
6354	85-BH-008-15.0-S	15	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-016-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-017-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-018-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-019-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-020-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-020-00-SSD	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-021-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-022-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-1-GR-023-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
Firing Site 2								
6615	85-2-GR-011-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-2-GR-012-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-2-GR-013-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-2-GR-013-00-SSD	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-2-GR-014-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-2-GR-015-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6433	85-1-GR-029-0-SSO	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6433	85-1-GR-030-0-SSO	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)

Refer to footnotes at end of table.

Table 10.4.4-2 (Continued)
Summary of SWMU 85 Confirmatory Soil Sampling HE Analytical Results, April—October 1997

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)							
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino, 4,6-dinitrotoluene	4-Amino, 2,6-dinitrotoluene	o-Nitrotoluene (2)	m-Nitrotoluene (3)	p-Nitrotoluene (4)
6433	85-1-GR-031-0-SSO	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
6433	85-1-GR-032-0-SSO	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
6433	85-1-GR-032-0-SSD	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
Firing Site 3										
6614	85-GR-006-00-SS	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
6614	85-GR-007-00-SS	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	(ND (10.6)
6614	85-GR-008-00-SS	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	ND (10.6)
6614	85-GR-009-00-SS	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	ND (10.6)
6614	85-GR-010-00-SS	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	ND (10.6)
6614	85-GR-010-00-SD	0	ND (5.67)	ND (6.18)	ND (6.48)	ND (6.6)	ND (5.45)	ND (7.83)	ND (11.1)	ND (10.6)
Firing Site 4										
6615	85-4-GR-021-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-022-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-023-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-024-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-025-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-026-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-027-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-028-00-SSO	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
6615	85-4-GR-028-00-SSD	0	ND (110)	ND (160)	ND (190)	ND (130)	ND (55)	ND (70)	ND (160)	ND (170)
Quality Assurance/Quality Control Sample (µg/L [water])										
6354	85-1-BH-008-EB (equipment blank)	NA	ND (0.030)	ND (0.11)	ND (0.070)	ND (0.040)	ND (0.050)	ND (0.030)	ND (0.020)	ND (0.030)
6433	85-1-GR-032-EB (equipment blank)	NA	ND (0.0293)	ND (0.0137)	ND (0.0425)	ND (0.0186)	ND (0.0195)	ND (0.0238)	ND (0.0312)	ND (0.0335)
6614	85-GR-010-00-EB (equipment blank)	NA	ND (0.0293)	ND (0.0137)	ND (0.0425)	ND (0.0186)	ND (0.0195)	ND (0.0238)	ND (0.0312)	ND (0.0335)
6615	85-4-GR-028-00-EB (equipment blank)	NA	ND (0.030)	ND (0.11)	ND (0.070)	ND (0.040)	ND (0.050)	ND (0.030)	ND (0.020)	ND (0.030)

Refer to footnotes at end of table.

Table 10.4.4-2 (Concluded)
Summary of SWMU 85 Confirmatory Soil Sampling HE Analytical Results, April—October 1997

Sample Attributes			Explosives, Methods (EPA 8330[a]) (µg/kg)					
Record Number[b]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Nitrobenzene	1,3 Dinitrobenzene	1,3,5 Trinitrobenzene	RDX	Tetryl	HMX
6433	85-1-GR-031-0-SSO	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6433	85-1-GR-032-0-SSO	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6433	85-1-GR-032-0-SSD	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
Firing Site 3								
6614	85-GR-006-00-SS	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6614	85-GR-007-00-SS	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6614	85-GR-008-00-SS	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6614	85-GR-009-00-SS	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6614	85-GR-010-00-SS	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
6614	85-GR-010-00-SD	0	ND (5.21)	ND (4.05)	ND (6.62)	ND (9.71)	ND (7.55)	ND (5.27)
Firing Site 4								
6615	85-4-GR-021-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-022-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-023-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-024-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-025-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-026-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	8400
6615	85-4-GR-027-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-028-00-SSO	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
6615	85-4-GR-028-00-SSD	0	ND (150)	ND (100)	ND (70)	ND (190)	ND (340)	ND (420)
Quality Assurance/Quality Control Sample (µg/L [water])								
6354	85-1-BH-008-EB (equipment blank)	NA	ND (0.040) AR	ND (0.030) AR	ND (0.040) AR	ND (0.20) AR	ND (0.040) AR	ND (0.080) AR
6433	85-1-GR-032-EB (equipment blank)	NA	ND (0.0161)	ND (0.0202)	ND (0.0206)	ND (0.0185)	ND (0.0215)	ND (0.0459)
6614	85-GR-010-00-EB (equipment blank)	NA	ND (0.0161)	ND (0.0202)	ND (0.0206)	ND (0.0185)	ND (0.0215)	ND (0.0459)
6615	85-4-GR-028-00-EB (equipment blank)	NA	ND (0.040)	ND (0.030)	ND (0.040)	ND (0.20)	ND (0.040)	ND (0.080)

[a]EPA November 1986.
[b]Analysis request/chain of custody record.

A = Laboratory accuracy and/or bios measurements for the associated laboratory control sample (LCS) do not meet acceptance criteria.
BH = Borehole.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
ID = Identification.
µg/kg = Micrograms per kilogram.
µg/L = Micrograms per liter.
NA = Not applicable.
ND ( ) = Not detected above the method detection limit, shown in parenthesis.
NT = Not tested.
NG = Nitroglycerin.
PETN = 1,3-dinitrato-2,2-bis(nitratomethyl) propane.
R = The data are unusable for their intended purpose (Note: the analyte may or may not be present).
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
S, SS, SSO = Soil sample.
SD and SSD = Soil sample duplicate.
TETRYL = 2,4,6-trinitrophenylmethylnitramine.

Table 10.4.4-3
Summary of SWMU 85 Confirmatory Soil Sampling Gamma Spectroscopy Analytical Results, April—October 1997

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Uranium-238 Result	Uranium-238 Error[b]	Thorium-232 Result	Thorium-232 Error[b]	Uranium-235 Result	Uranium-235 Error[b]	Cesium-137 Result	Cesium-137 Error[b]
Firing Site 1										
6353	85-BH-006-0.0-S	0	ND (3.25E+00)	--	7.07E-01	3.74E-01	ND (2.38E-01)	--	2.95E-02	2.59E-02
6353	85-BH-006-0.0-SD	0	ND (3.43E+00)	--	7.37E-01	3.91E-01	ND (2.53E-01)	--	3.00E-02	1.89E-02
6353	85-BH-006-5.0-S	5	ND (3.58E+00)	--	6.59E-01	3.33E-01	ND (2.59E-01)	--	ND (3.96E-02)	--
6353	85-BH-006-10.0-S	10	ND (3.98E+00)	--	7.39E-01	4.11E-01	ND (2.96E-01)	--	ND (4.00E-02)	--
6353	85-BH-006-15.0-S	15	ND (3.77E+00)	--	ND (1.75E-01)	--	ND (1.80E-01)	--	ND (4.04E-02)	--
6341	85-BH-007-0.0-S	0	ND (1.41E+00)	--	7.69E-01	4.25E-01	ND (1.94E-01)	--	3.09E-02	1.90E-02
6353	85-BH-007-0.0-SD	0	ND (3.34E+00)	--	7.11E-01	3.49E-01	ND (2.53E-01)	--	1.43E-02	1.51E-02
6353	85-BH-007-5.0-S	5	ND (3.69E+00)	--	6.73E-01	4.12E-01	ND (2.73E-01)	--	ND (3.66E-02)	--
6353	85-BH-007-10.0-S	10	ND (2.10E+00)	--	8.34E-01	4.55E-01	ND (2.48E-01)	--	ND (4.72E-02)	--
6341	85-BH-007-15.0-S	15	1.21E+00	1.14E+00	7.71E-01	4.38E-01	ND (2.15E-01)	--	ND (4.45E-02)	--
6353	85-BH-008-0.0-S	0	ND (2.05E+00)	--	8.24E-01	4.50E-01	ND (2.76E-01)	--	ND (5.25E-02)	--
6353	85-BH-008-0.0-SD	0	6.42E-01	1.16E+00	7.53E-01	4.14E-01	1.41E-01	1.78E-01	ND (4.84E-02)	--
6341	85-BH-008-5.0-S	5	ND (1.40E+00)	--	6.27E-01	3.20E-01	ND (1.96E-01)	--	ND (3.91E-02)	--
6353	85-BH-008-10.0-S	10	ND (1.79E+00)	--	7.12E-01	3.91E-01	ND (2.52E-01)	--	ND (4.69E-02)	--
6341	85-BH-008-15.0-S	15	9.91E-01	1.04E+00	8.32E-01	4.58E-01	ND (2.27E-01)	--	ND (4.47E-02)	--
6344	85-1-GR-016-00-SSO	0	ND (1.49E+00)	--	6.71E-01	3.80E-01	ND (2.05E-01)	--	2.36E-02	1.85E-02
6344	85-1-GR-017-00-SSO	0	ND (1.42E+00)	--	5.87E-01	3.53E-01	ND (2.02E-01)	--	ND (3.93E-02)	--
6344	85-1-GR-018-00-SSO	0	ND (1.52E+00)	--	6.81E-01	3.35E-01	ND (2.10E-01)	--	2.21E-02	3.23E-02
6344	85-1-GR-019-00-SSO	0	ND (1.45E+00)	--	7.14E-01	3.46E-01	ND (1.96E-01)	--	ND (3.60E-02)	--
6345	85-1-GR-020-00-SSO	0	ND (1.42E+00)	--	6.37E-01	3.41E-01	ND (1.98E-01)	--	ND (3.91E-02)	--
6344	85-1-GR-020-00-SSD	0	ND (1.42E+00)	--	6.12E-01	3.31E-01	ND (1.97E-01)	--	ND (3.80E-02)	--
6344	85-1-GR-021-00-SSO	0	ND (1.62E+00)	--	8.72E-01	4.55E-01	ND (2.19E-01)	--	ND (3.84E-02)	--
6344	85-1-GR-022-00-SSO	0	ND (1.42E+00)	--	6.68E-01	3.76E-01	ND (1.91E-01)	--	ND (3.57E-02)	--
6344	85-1-GR-023-00-SSO	0	ND (1.45E+00)	--	7.27E-01	4.56E-01	ND (2.01E-01)	--	2.26E-02	3.34E-02
Firing Site 2										
6344	85-2-GR-011-00-SSO	0	2.18E+00	1.09E+00	6.69E-01	3.65E-01	ND (2.12E-01)	--	2.04E-02	2.27E-02
6344	85-2-GR-012-00-SSO	0	2.67E+01	6.58E+00	6.49E-01	4.12E-01	5.38E-01	2.06E-01	1.40E-02	1.50E-02
6345	85-2-GR-013-00-SSO	0	1.71E+01	4.45E+00	ND (1.77E-01)	--	3.84E-01	1.47E-01	ND (2.26E-02)	--
6344	85-2-GR-013-00-SSD	0	6.51E+00	2.02E+00	7.55E-01	4.35E-01	2.25E-01	3.51E-01	ND (4.45E-02)	--
6344	85-2-GR-014-00-SSO	0	1.63E+01	4.09E+00	5.65E-01	3.30E-01	3.02E-01	3.18E-01	ND (4.19E-02)	--
6344	85-2-GR-015-00-SSO	0	ND (1.66E+00)	--	6.90E-01	3.59E-01	ND (2.31E-01)	--	ND (4.13E-02)	--
6434	85-1-GR-029-0-SSO	0	1.31E+01	4.48E+00	6.55E-01	3.40E-01	3.19E-01	1.53E-01	1.27E-02	1.37E-02
6435	85-1-GR-030-0-SS	0	1.77E+00	1.74E+00	5.18E-01	2.75E-01	ND (1.95E-01)	--	1.72E-02	2.31E-02
6435	85-1-GR-031-0-SS	0	ND (1.47E+00)	--	6.26E-01	3.30E-01	ND (8.94E-02)	--	ND (3.87E-02)	--
6435	85-1-GR-032-0-SSO	0	1.87E+00	1.90E+00	7.07E-01	3.89E-01	ND (2.21E-01)	--	ND (3.93E-02)	--
6435	85-1-GR-032-0-SSD	0	ND (1.54E+00)	--	7.69E-01	4.00E-01	ND (2.04E-01)	--	ND (4.01E-02)	--
Firing Site 3										
6340	85-GR-006-00-SS	0	ND (3.98E+00)	--	9.55E-01	5.10E-01	ND (2.83E-01)	--	ND (4.22E-02)	--
6340	85-GR-007-00-SS	0	ND (3.72E+00)	--	ND (1.65E-01)	--	ND (2.71E-01)	--	ND (3.69E-02)	--
6340	85-GR-008-00-SS	0	ND (3.65E+00)	--	8.28E-01	1.40E-01	ND (2.77E-01)	--	ND (3.53E-02)	--
6340	85-GR-009-00-SS	0	ND (3.51E+00)	--	8.26E-01	4.22E-01	ND (2.53E-01)	--	ND (3.53E-02)	--
6340	85-GR-010-00-SS	0	ND (3.45E+00)	--	6.67E-01	3.80E-01	ND (2.57E-01)	--	ND (3.55E-02)	--

Refer to footnotes at end of table.

Table 10.4.4-3 (Concluded)
Summary of SWMU 85 Confirmatory Soil Sampling Gamma Spectroscopy Analytical Results, April—October 1997

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
6339	85-GR-010-00-SD	0	ND (1.51E+00)	--	8.14E-01	4.03E-01	ND (2.11E-01)	--	ND (4.65E-02)	--
Firing Site 4										
6344	85-4-GR-021-00-SSO	0	ND (1.35E+00)	--	4.84E-01	2.81E-01	ND (1.84E-01)	--	2.13E-01	4.89E-02
6344	85-4-GR-022-00-SSO	0	6.09E-01	2.78E-01	7.89E-01	4.11E-01	ND (2.01E-01)	--	1.03E-01	5.29E-02
6345	85-4-GR-023-00-SSO	0	ND (8.91E-01)	--	7.38E-01	3.59E-01	ND (8.98E-02)	--	3.47E-01	7.37E-02
6344	85-4-GR-024-00-SSO	0	8.21E-01	7.73E-01	6.38E-01	3.13E-01	ND (1.94E-01)	--	3.61E-01	1.04E-01
6344	85-4-GR-025-00-SSO	0	1.21E+00	7.84E-01	5.43E-01	2.95E-01	ND (1.68E-01)	--	2.66E-02	4.79E-02
6344	85-4-GR-026-00-SSO	0	ND (1.40E+00)	--	7.10E-01	3.62E-01	ND (1.97E-01)	--	1.09E-01	3.06E-02
6344	85-4-GR-027-00-SSO	0	ND (1.42E+00)	--	6.46E-01	4.41E-01	ND (1.95E-01)	--	8.48E-02	2.72E-02
6345	85-4-GR-028-00-SSO	0	ND (1.50E+00)	--	6.39E-01	4.00E-01	ND (2.14E-01)	--	1.37E-02	1.39E-02
6345	85-4-GR-028-00-SSD	0	ND (1.47E+00)	--	6.54E-01	3.90E-01	ND (2.03E-01)	--	ND (1.91E-02)	--
1307	14E1C-SS	0	5.23	1.88	5.10E-01	2.06E-01	ND (3.91E-01)	--	ND (5.21E-02)	--
1307	14E1D-SS	0	1.09E+01	2.82	3.89E-01	1.97E-01	ND (4.51E-01)	--	ND (5.89E-02)	--
6353	14-GR-090297	0	6.55E+00	2.19E+00	5.67E-01	3.35E-01	1.44E-01	1.20E-01	2.50E-02	3.98E-02
Quality Assurance/Quality Control Sample (pCi/L)										
6353	85-BH-008-EB (equipment blank)	NA	ND (8.15E-01)	--	ND (1.53E-01)	--	ND (1.39E-01)	--	ND (2.56E-02)	--
6435	85-1-GR-032-EB (equipment blank)	NA	ND (7.65E-01)	--	ND (1.56E-01)	--	ND (1.31E-01)	--	ND (2.74E-02)	--
Approved SNL/NM SWTA Surface/Subsurface Background Soil Concentrations[c]			1.4/1.4	NA	1.01/1.01	NA	0.16/0.16	NA	0.664/0.079	NA

[a]Analysis request/chain of custody record.
[b]Two standard deviation about the mean detected activity.
[c]From Dinwiddie September 1997.

BH	= Borehole.
ER	= Environmental Restoration.
ft	= Foot (feet).
GR	= Grab sample.
ID	= Identification.
NA	= Not applicable.
ND ( )	= Not detected above the minimum detectable activity, shown in parenthesis.
NT	= Not tested.
pCi/g	= Picocurie(s) per gram.
pCi/L	= Picocurie(s) per liter.
S, SS, and SSO	= Soil sample.
SD and SSD	= Soil sample duplicate.
SNL/NM	= Sandia National Laboratories/New Mexico.
SWTA	= Southwest Test Area.
UTL	= Upper tolerance limit.
--	= Error not calculated for nondetected results.

Table 10.4.4-4
Summary of SWMU 85 Confirmatory Soil Sampling Isotopic Uranium Analytical Results, April—October 1997

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)					
			Uranium-233/234[b]		Uranium-235[b]		Uranium-238[b]	
Record Number[a]	ER Sample ID (Figures 10.4.4-1, 10.4.4-2, and 10.4.4-3)	Sample Depth (ft)	Result	Error[b]	Result	Error[b]	Result	Error[b]
6433	85-1-GR-029-0-SSO	0	0.757	0.168	0.0852	0.0493	3.08	0.461
6433	85-1-GR-030-0-SSO	0	0.380	0.112	0.0254	0.0309	0.414	0.118
6433	85-1-GR-031-0-SSO	0	0.394	0.115	0.0334	0.0351	0.442	0.124
6433	85-1-GR-032-0-SSO	0	0.909	0.186	0.0836	0.0474	3.15	0.467
6433	85-GR-032-00-SSD	0	0.459	0.128	0.0412	0.0356	0.544	0.141
6614	85-GR-006-00-SS	0	0.571	0.0888	0.0191	0.0128	0.636	0.133
6614	85-GR-007-00-SS	0	0.730	0.11	0.0288	0.0139	0.731	0.152
6614	85-GR-008-00-SS	0	0.575	0.095	0.0512	0.0205	0.625	0.136
6614	85-GR-009-00-SS	0	0.754	0.112	0.0218	0.0156	0.792	0.164
6614	85-GR-010-00-SS	0	0.497	0.0841	0.0347	0.0166	0.596	0.129
6614	85-GR-010-00-SD	0	0.482	0.0774	0.0266	0.0146	0.566	0.12
Quality Assurance/Quality Control Sample (pCi/L)								
6433	85-1-GR-032-EB (equipment blank)	NA	ND (0.0874)	--	ND (0.0355)	--	ND (0.0478)	--
6614	85-GR-010-EB (equipment blank)	NA	0.104	0.0386	ND (0.0382)	--	0.0728	0.0322
Approved SNL/NM SWTA Surface/Subsurface Background Soil Concentrations[c]			1.6/1.6	NA	0.16/0.16	NA	1.4/1.4	NA

[a]Analysis request/chain of custody record.
[b]Two standard deviation about the mean detected activity.
[c]From Dinwiddie September 1997.

BH	= Borehole.
ER	= Environmental Restoration.
ft	= Foot (feet).
GR	= Grab sample.
ID	= Identification.
NA	= Not applicable.
ND ( )	= Not detected above the minimum detectable activity, shown in parenthesis.
NT	= Not tested.
pCi/g	= Picocurie(s) per gram.
pCi/L	= Picocurie(s) per liter.
S, SS, and SSO	= Soil sample.
SD and SSD	= Soil sample duplicate.
SNL/NM	= Sandia National Laboratories/New Mexico.
SWTA	= Southwest Test Area.
UTL	= Upper tolerance limit.
--	= Error not calculated for nondetected results.

Explosives

For HE, all analytes were below the detectable limits except for 1,3,5,7-tetranitro-1,3,5,7-tetrazucyclooctane (HMX) in one sample (85-004-GR-026-0.0-SSO). The HMX concentration at this location was 8,400 micrograms per kilogram (µg/kg). This surface soil sample was collected near the center of Firing Site 4. In other samples from the immediate area (85-004-GR-027-0.0-SSO and, 85-004-GR-028-0.0-SSO), HMX values were below detection limits, which suggests the 8,400 µg/kg sample may be a local anomaly.

Radioisotopes

The radioisotope activities that were evaluated for SWMU 85 include the Geotech VCM samples that were collected in September 1995, the screening samples that were collected by SNL/NM in July 1995, and the confirmation samples that were collected by SNL/NM from April through October 1997. All radiological data were considered to be at a quality level sufficient for a risk assessment. Thorium-232 was the only radioisotope with activities from both surface and subsurface soils below the NMED-approved background levels of 1.01 picocuries per gram (pCi/g).

Cesium-137 was detected below background levels for surface soils. Although the MDA was variable among the samples for cesium-137, it was detected at levels below the approved background levels. One subsurface soil sample was above the background level of 0.079 pCi/g for cesium-137 (at 0.347 pCi/g).

All uranium-235 subsurface soil samples were detected below background level (0.16 pCi/g). Five surface samples were above the approved background level (0.16 pCi/g) for uranium-235. The maximum value of these five samples was 0.538 pCi/g.

Uranium-238 was detected above background in both the surface and subsurface soils. Eight of the surface samples were above the background levels (1.4 pCi/g). Activities for the eight samples were detected at ranges of from 1.77 to 26.7 pCi/g. One sample was detected above the background level (1.4 pCi/g) in subsurface soils. The activity for this sample was 99.1 pCi/g.

Alpha spectroscopy was performed on the grab samples collected from around the VGES tank at Firing Site 2 (ER-85-GR-029-0.0-SS, ER-85-GR-030-0.0-SS, ER-85-GR-031-0.0-SS, and ER-85-GR-032-0.0-SS) and Firing Site 3 (85-GR-006-00-SS, 85-GR-007-00-SS, 85-GR-008-00-SS, 85-GR-009-00-SS, and 85-GR-010-00-SS). The maximum alpha activity was detected at 0.909 pCi/g for isotopic uranium; 0.0852 pCi/g for uranium-235; and 3.15 pCi/g for uranium-238.

10.4.4.5 QA/QC

Tables 10.4.3-1 and 10.4.3-4 show the QA/QC results for metals. Two field blanks (85-BH-15-FB for Record Number 3982 and 85-BH5-15-FB for Record Number 50942), and two equipment blanks (85-BH5-15-EB for Record Number 3982 and 85-BH-15-EB for Record Number 50942) from the screening sample event were analyzed for metals. Results revealed no detections for metals. HE results also revealed no detections (Tables 10.4.3-3 and 10.4.3-2). However, an H qualifier was assigned to the results because holding times were missed by the on-site laboratory. Results for QA samples for the screening samples all revealed no detections for gamma radiation (Table 10.4.3-2); however, alpha radiation was detected in the field blank and in the equipment blank (Table 10.4.4-3).

Four equipment blanks (85-1BH-008-EB, 85-GR-010-00-EB, 85-4-GR-028-00-EB, 85-1-GR-032-EB) from the confirmatory sampling event were analyzed for metals (Table 10.4.4-1). Results of the blank analyses revealed concentrations of several metals detected below the quantifiable detection limits. Barium was detected in three of the four samples. Chromium was detected in two of the four samples, and there was one detection for silver. Results revealed no detections for HE in the four QA samples (Table 10.4.4-2). However, sample 85-1-BH-008-EB was given an A, R qualifier, signifying that the laboratory accuracy and bias measurement for the LCS did not meet acceptance criteria (the A qualifier) and is therefore not usable for its intended purpose (the R Qualifier). All other QA results met acceptance criteria. Two of the equipment blanks were analyzed for radiological activity using gamma spectroscopy, and two were analyzed for isotopic uranium using alpha spectroscopy (Table 10.4.4-3). For gamma radiation, the results revealed no detections. For isotopic uranium, the results revealed values of 0.001 pCi/g for uranium-233/234, 0.007 pCi/g for uranium-235 and 0.07 pCi/g for uranium-238 from sample 85-GR-010-EB.

10.4.4.6 Data Validation

Metals

The confirmatory data sampling data were validated at Level III data quality level. For the metals for Analysis Request/Chain of Custody (AR/COC) 6615, the data are considered acceptable, and the QC results are adequate; however, field precision did not meet acceptance criteria for the associated field duplicate pair. In addition, the relative percent difference (RPD) for the MS/MSD did not meet the criteria for lead. Because of sample heterogeneity associated with the soil samples, lead were results assigned J values for the samples associated with sample pair 85-1-GR-020-SSO, 85-1-GR-020-SSD. This is consistent where RPD exceeds 20 percent and 35 percent for technical review purposes. The matrix blank shows lead at levels above the reportable detection limits. No data are qualified in the equipment blank (Sample Number 85-4-GR-028-00-EB) because the sample results are greater than five times the blank.

For AR/COC 6354 metals, the QC results are acceptable. The field duplicate pairs show an RPD outside the control limits for chromium. The sample results for these associated samples were J valued.

Organics

For organic results for AR/COC 6615, all data are acceptable and QC measures are adequate. No data are qualified.

For AR/COC 6354 for organic results, the laboratory accuracy for LCS did not meet the acceptance criteria. The data are not usable for the intended purposes. The LCS percent recoveries were below the acceptable limits for half the analyses in the LCS. No LCSD was reported, and no MS/MSD were run on the samples from AR/COC 6354. The MS/MSD was reported from AR/COC 6615 and met the limits. The sample results were assigned A,R values, because in the samples yielded no detections. The LCSD percent recovery for the aqueous samples was below the acceptance limits for over half of the analytes in the LCSD. The LCS met the acceptance limits, but the MS/MSD did not. Because no analytes were detected, all associated sample results were assigned qualified A, R values. It is noted that although the explosives data analyses were not acceptable as Level III data, the results do compare favorably with the results for AR/COC 6615, which is acceptable, and with the screening sample results shown in Table 10.4.3-3. All these data revealed no detections. The unacceptable Level III data were, therefore, not used for risk assessment purposes. The results, however, are comparable to the acceptable Level III data. This correlation provides strong evidence for the absence of explosives contamination at the site.

10.5 Site Conceptual Model

Section 10.5 describes the conceptual model for SWMU 85 and summarizes the nature and extent of contamination and the environmental fate of COCs.

10.5.1 Nature and Extent of Contamination

Review of the analytical data at SWMU 85 identified several COC at concentrations above approved background limits, including arsenic, barium, chromium, lead, nickel, and silver for metals; HMX for explosives; and the radiological constituents uranium-238 and uranium-235 (see Table 10.5.1-1). Mercury, silver, selenium, and cadmium do not have quantified background limits; therefore, it is not known whether these constituents exceed background and are included in Table 10.5.1-1. These COCs, however, do not pose significant risk to human health or the environment, based upon maximum concentrations detected in surface and subsurface soils at SWMU 85. The nature and extent of contamination is discussed below.

<u>Firing Site 1</u>

The metals arsenic, barium, chromium, nickel, and lead were all detected above approved background limits at Firing Site 1. Chromium (at 23 J mg/kg) occurred in one surface soil sample (85-BH-008-0.0-SS) above approved background levels (21.4 mg/kg). Barium also occurred over approved background levels at six surface soil locations. The maximum concentration at Firing Site 1 were 400 mg/kg. Barium (at 370 mg/kg) was also detected above approved background limits in one borehole (85-BH-8-5.0-SS) at a depth of 5 feet.

Lead occurred above approved background limits at seven surface soil locations. The maximum concentration detected at Firing Site 1 was 380 PJ mg/kg. No lead was detected above approved background limits in the boreholes at this location.

Arsenic and nickel occurred above approved background limits in one subsurface location, BH.6. The maximum concentration for these COCs were 4.6 and 38 mg/kg, respectively.

No HE were detected at Firing Site 1, and the radiological activities were all below background levels.

Table 10.5.1-1
Summary of COCs for SWMU 85

COC Type	Number of Samples (surface/ subsurface)	COCs greater than background	Maximum Background Limit/SWTA[a] (surface/subsurface except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration[b] (surface/subsurface) (mg/kg except where noted)	Sampling Locations Where Background Concentration Limit Exceeded
Inorganic Nonradionuclides	41/9	Barium	130 / 214	400/370	115/162	85-BH-006-00-S, 85-BH-006-0.0-SD, 85-BH-007-0.0-S, 85-BH-007-0.0-SD, 85-1-GR-016-0.0-SSO, 85-1-GR-017-0.0-SSO, 85-1-GR-018-0.0-SSO, 85-GR-019-0.0-SSO, 85-1-GR-020-SSD, 85-4-GR-025-0.0-SSO, 85-BH-008-5.0-S
		Chromium	17.3/15.9	23/NA[c]	9.06/NA	85-BH-008-0.0-SS
		Lead	21.4/11.8	380 PJ/NA	35.5/NA	85-BH-006-0.0-S, 85-BH-006-0.0-SD, 85-1-GR-017-0.0-SSD, 85-1-GR-016-0.0-SSO, 85-1-GR-018-0.0-SSO, 85-1-GR-019-0.0-SSO, 85-1-GR-020-0.0-SSO, 85-1-GR-023-0.0-SSO
		Silver	<1.0/<1.0	3.0/NA	0.3/0.11(ND)	85-GR-007-0.0-SS
		Arsenic	5.6/4.4	NA/4.6	NA/3.4	85-BH-006-10-S
		Cadmium	<1.0[d]/0.9	0.399/NA	0.21/NA	All surface samples were less than the nonquantified background values
		Mercury	<0.25/<0.1	0.165 J/ND (all)	0.077/0.11	All surface samples were less than the nonquantified background values
		Nickel	11.5/11.5	NA/38	NA/11.8	85-BH-006-5.0-S
		Selenium	<1[d]/<1[d]	0.815/0.38 J	0.523/0.33	All surface samples were less than the nonquantified background values
Explosives	41/9	HMX	NA	8400 µg/kg	Not calculated[e]	85-4-GR-026-0.0-SSO
Radionuclides		U-238	1.4/1.4 pCi/g	26.7/1.21 pCi/g	Not calculated[f]	85-2-GR-012-0.0-SSO, 85-2-GR-013-0.0-SSO, 85-2-GR-013-0.0-SSD, 85-2-GR-014-0.0-SSO, 85-1-GR-030-0.0-SS, 85-1-GR-032-0.0-SSO, 85-2-GR-011-SSO, 85-4-GR-025-0.0-SSO, 14E1C-SS, 14E1D-SS, 14-GR-090297
		U-235	0.16/0.16 pCi/g	0.54/NA pCi/g	Not calculated[f]	85-2-GR-012-0.0-SSO, 85-2-GR-013-0.0-SSO, 85-2-GR-013-0.0-SSD, 85-2-GR-014-0.0-SSO,

[a]From Dinwiddie (September 1997).
[b]Average concentration includes all samples and duplicates, and nondetects with MDLs greater than background.
[c]All values are below background levels.
[d]Unquantified background levels.
[e]HMX was detected in one sample. All others were nondetect.
[f]An average minimum detectable activity (MDA) is not calculated due to the variability of the counting error and the number of reported nondetectable activities. These nondetectable activities are solely a function of instrument counting duration, rather than an indication of the presence or absence of a specific radionuclide in the environment.

µg/kg = Microgram(s) per kilogram.
COC = Constituent of concern.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
PJ = Laboratory precision measurements do not meet acceptance criteria.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.

Contamination at Firing Site 1 consists of barium, lead, and chromium that extends laterally and to the area around the cable run boxes (Figure 10.4.4-1). The contamination extends vertically no deeper than 5 feet bgs (e.g., barium in BH-8 at a concentration of 370 mg/kg). At 10 and 15 feet bgs, barium is below the NMED-approved subsurface background limit.

Firing Site 2

No nonradiological metals were detected above approved background limits at Firing site 2 and no explosives were detected. The primary COCs at Firing Site 2 are the radionuclides uranium-238 and uranium-235. These constituents appear to be centered on the VGES tank, which would be their likely source (Figure 10.4.4-1). The horizontal extent of radiological contamination was defined by the RUST Geotech Inc. survey and VCM that were conducted in July and September 1995 and from March through June 1996. RUST Geotech Inc. removed all contamination that was 30 percent greater than local background. However, the confirmation sampling that was conducted from September through October 1997 indicates that some soil contamination at levels greater than NMED-approved background levels remains. The maximum activities are 2.67 pCi/g for uranium-238 and 0.31 pCi/g for uranium-235. These values are within acceptable risk levels as discussed in Annex 10-C.

The subsurface soils at Firing Site 2 were investigated in the SWMU 14 investigation (SNL/NM June 1998). Sample locations ER14-TR1-003-3.0-TR and ER14-TR6-018-3.0-TR were collected at a depth of 3 feet in the area of the VGES tank (see Figure 3.4.4-1 and Tables 3.4.4-1, 3.4.4-2 and 3.4.4-3 in Annex 10-C). When compared to approved background limits, these data shows that metals and radionuclides are within acceptable limits and HE is nondetect at this depth. Impact to the subsurface soils from these COCs was determined to be minimal (see Annex 10-C). These results are described more completely in the SWMU 14 NFA Proposal (SNL/NM June 1998).

Firing Site 3

Silver (at 3.00 mg/kg) was the only metal detected at a concentration above background at Firing Site 3 in one sample (85-GR-007-0.0-SS) (Figure 10.4.4-2). No explosives were detected at levels above approved background limits. Gamma activities for thorium-234 (85-GR-007-0.0-SS) and radium-228 (85-GR-006-0.0-SS and 85-GR-007-0.0-SS) were detected above NMED-approved background levels.

Firing Site 4

Barium, the only nonradiological metal detected above approved background limits at Firing Site 4, was detected in surface soil sample 85-4-GR-025-0.0-SSO (Figure 10.4.4-3). The explosive compound HMX was detected in 85-4-GR-026-0.0-SSO. Uranium-238 was the only radiological metal of concern that was detected above background. Contamination at Firing Site 4 appears to be localized in the immediate area of these samples. The sample 85-4-GR-026 0.0-SSO was collected near the center of the firing site, which would be the immediate firing test area. This was near an area of discolored surface soils. This material was black carbonaceous material that occurred as a thin (less than 2-inch-thick) discontinuous layer in the immediate area of 85-4-GR-027-0.0-SS. This material covers an approximate area of less than 100 square feet.

No hazardous or radiological constituents were detected above NMED-approved background levels in this sample. Explosives detections were below the background limits.

The barium and uranium that were detected in 85-4-GR-025-0.0-SSO appear to be local anomalies. This location is 200 feet from the center of the test site. It is unlikely that this material is anthropogenic. Concentrations/activities of these constituents would be expected to be higher closer to the point of origin of the firing test (i.e., the center of the firing site). Concentrations in samples from this area were all at less than NMED-approved background limits. This material may, therefore, reflect a local soil anomaly, and the extent of contamination appears to be confined to the HMX anomaly at 85-4-GR-026-SS.

10.5.2 Environmental Fate

From the background interviews and from knowledge of the site operations, the primary sources of COCs at SWMU 85 were nonradiological metals (primarily beryllium) and HE from subsurface firing tests at Firing Site 1; DU and metals from the steam reaction tests at the VGES tank on the surface soil at Firing Site 2; and DU, C-4 explosives, and barium from Baratol explosives on the surface of the firing sites from surface tests.

The primary nonradiological metals that were detected above NMED-approved background levels include arsenic, barium, chromium, nickel, lead, and silver. Mercury, cadmium, and selenium levels, however, must be considered in a risk assessment of the SWMU because they do not have quantified background concentrations. Radiological constituents above background levels include uranium-238 and uranium-235. The explosive, HMX was also detected (see Table 10.5.1-1).

Figure 10.5.2-1 shows the environmental fate for the constituents at SWMU 85. The current and future projected land uses for SWMU 85 are industrial (DOE and USAF March 1996.) The potential human receptor is the industrial worker. Exposure routes to industrial workers would be through dust emissions from surface soil and dust contamination through ingestion or by external irradiation. Ecological receptors would be more affected by the uptake of biota, ingestion and dermal contact of surface-water runoff, and percolation to the vadose zone.

Several factors preclude a groundwater pathway as a potential exposure route. The infiltration rates for the SWTA have been determined to be on the order of 0.002 to 0.071 cm/yr, and seepage rates from 0.03 to 11.8 cm/yr (see Section 10.2.1). Groundwater has been estimated to be at an approximate depth of 347 feet bgs. High-partitioning coefficients and low mobility of the ions of the COCs would dilute the low concentrations of these constituents even more. For these reasons, groundwater was not evaluated as a contaminant migration pathway.
Annex 10-C provides additional discussion of the exposure routes and receptors at SWMU 85.

10.6 Site Assessments

10.6.1 Summary

The site assessment concludes that SWMU 85 does not have significant potential to affect human health under an industrial land-use scenario. After consideration of the uncertainties associated with the available data and modeling assumptions, ecological risks associated with

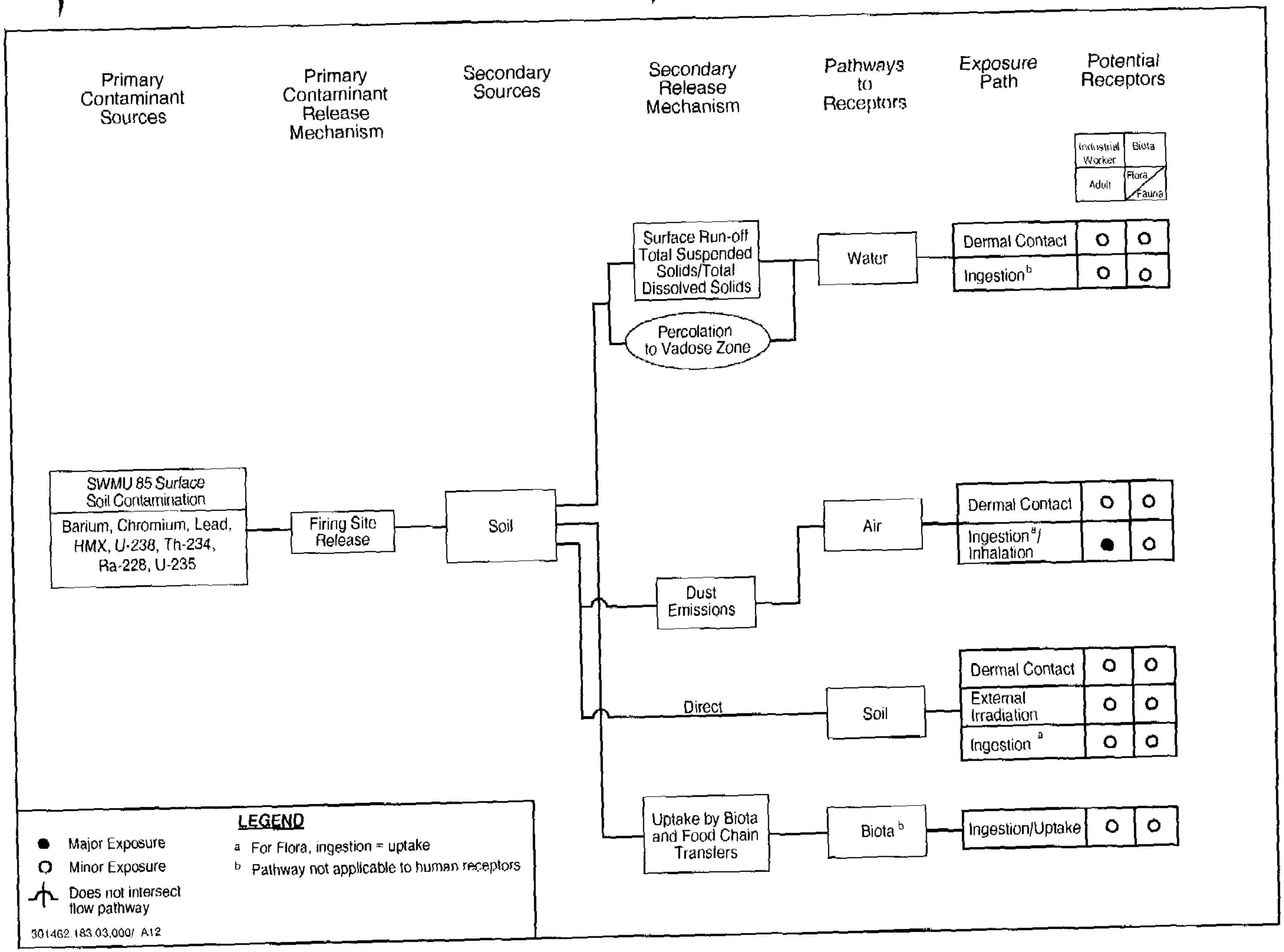


Figure 10.5.2-1

Conceptual Model Flow Diagram for SWMU 85, Building 9920 – Firing Site

SWMU 85 were found to be insignificant. This section briefly describes and Annex 10-C provides detailed descriptions of the site assessments.

10.6.2 Screening Assessments

10.6.2.1 Human Health

SWMU 85 has been recommended for industrial land-use (DOE and USAF March 1996). Annex 10-C provides a complete discussion of the risk assessment process, results, and uncertainties.

Because COCs are present in concentrations or activity levels greater than background levels, it was necessary to perform a health risk screening assessment analysis for the site. Besides COC metals, this assessment included any HE detected above their reporting limits and any radionuclide compounds detected either above background levels and/or MDAs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Assessment Report calculated the hazard index (HI) and excess cancer risk for both an industrial land-use and residential land-use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

In summary, the HI calculated for SWMU 85 nonradiological COCs is 0.03 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental HI is 0.02. The total excess cancer risk for SWMU 85 nonradiological COCs is 2E–6 for an industrial land use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less that 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). Thus, the total excess cancer risk for this site is above the suggested acceptable risk value (1E-6). However, the incremental excess cancer risk for SWMU 85 is 5E-8, which is below proposed guidelines.

The incremental total effective dose equivalent for radionuclides for an industrial land-use setting for SWMU 85 is 7.4E-1 millirem (mrem)/yr which is well below the recommended dose limit of 15 mrem/yr found in EPA's OSWER Directive No. 9200.4-18 and reflected in a document entitled "Sandia National Laboratories, New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The incremental excess cancer risk for radionuclides is 8.3E-6 for industrial land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values.

The residential land-use scenarios for this site are provided only for comparison in the Risk Assessment Report (Annex 10-C). The report concludes that SWMU 85 does not have significant potential to affect human health under an industrial land-use scenario.

10.6.2.2 Ecological

As set forth by the NMED Risk-Based Decision Tree, an ecological screening assessment that corresponds with the screening procedures (NMED March 1998) in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) was performed. An early step in the evaluation is comparing COC concentrations and identifying potentially bioaccumulative constituents. This is presented in Annex 10-C. This methodology also requires a site conceptual model and a food web model be developed and ecological receptors be selected. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/ New Mexico" (IT June 1998) and will not be duplicated here. The screening also includes estimation of exposure and ecological risk.

Tables 16, 17, 18, and 19 of Annex 10-C present the results of the ecological risk assessment screening. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients greater than unity were originally predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in the estimation of risk), exposure setting (area use factors of one were assumed), background risk, quality of analytical data, and use of detection limits as exposure concentrations. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be low.

10.7 No Further Action Proposal

10.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is being recommended for SWMU 85 for the following reasons:

- The nature and extent of contamination at SWMU 85 has been defined and are minimal.
- Human health and ecological risk evaluations indicate the COCs will have no significant impact on human health or the environment.

10.7.2 Criterion

Based upon the evidence provided above, SWMU 85 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that "the SWMU has been fully characterized and remediated in accordance with current and applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

REFERENCES

Author [unk] Date [unk]. Interview conducted for the Environmental Restoration Project, Department 7585, ER/7785/1335/108/INT/206, Sandia National Laboratories, Albuquerque, New Mexico.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB." September 24, 1997.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Fate, D. (Sandia National Laboratories/New Mexico). Memorandum to B. Marshall, Sandia National Laboratories, Albuquerque, New Mexico. June 1997.

Gaither, K. (Sandia National Laboratories/New Mexico). Memorandum to ERST Files, Sandia National Laboratories, Albuquerque, New Mexico. October 28, 1991.

Hoagland, S. and R. Dello-Russo, February 1995. "Cultural Resources Investigation for Sandia National Laboratories/New Mexico, Environmental Restoration Program, Kirtland Air Force Base, New Mexico," Butler Service Group, Albuquerque, New Mexico.

Hyndman, D.A., April 1997. "Geophysical Investigation of Environmental Site 117 and 14," Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

IT, see IT Corporation.

IT Corporation (IT), June 1998. "Predictive Ecological Risk Assessment Methodology for the SNL/NM ER Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, New Mexico Environment Department, Santa Fe, New Mexico.

Marshall, B.W., Jr., Memorandum of Record, Sandia National Laboratories, Albuquerque, New Mexico. September 15, 1993.

Martz, M.K. Interview conducted for the Environmental Restoration Project, Department 7585, ER/7585/1332/82/INT/85-111 and ER/7585/1335/INT/85-179, Sandia National Laboratories, Albuquerque, New Mexico. September 23, 1985.

Martz, M.K. Interview conducted for the Environmental Restoration Project, Department 7585, ER/7585/1335/INT/85, Sandia National Laboratories, Albuquerque, New Mexico. October 4, 1985a.

Martz, M.K. Interview conducted for the Environmental Restoration Project, Department 7585, ER/7585/INT/85-138, Sandia National Laboratories, Albuquerque, New Mexico. October 24, 1985b.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, Santa Fe, New Mexico.

NMED, see New Mexico Environment Department.

Perkins, B. Interview conducted for the Environmental Restoration Project, Department 7585, ER/7585/1335/85/INT/84, CEARP Notes, Sandia National Laboratories, Albuquerque, New Mexico. December 12, 1984.

RUST Geotech Inc. December 1994. "Final Report, Surface Gamma Radiation Surveys for Sandia National Laboratories/New Mexico Environmental Restoration Project," prepared for U.S. Department of Energy by RUST Geotech Inc., Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM) Date [unk]a. "Sandia National Laboratories, Environmental Restoration Program Information Sheet, Site 85," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), [unk]b. "Utility Plan and Details, Shock Wave Studies Laboratory Building 9926, Site 14, Engineering Drawing 89528," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), August 1982. "Site Plan West Conc. Test Structure, Flame Facility, Building 9920, Site 14, Engineering Drawing 97327/A1," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994. "Verification and Validation of Chemical and Radiochemical Data," TOP 94-03, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1994. "UXO/HE Visual Survey of SWMUs Final Report," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1995. "Site-Wide Hydrogeologic Characterization Project, Calendar Year 1994 Annual Report," Sandia National Laboratories Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), October 1995. "Chemical Waste Landfill Groundwater Assessment Report," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1996. "Sampling and Analysis Plan ER Site 85," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1996a. "RCRA Facility Investigation Work Plan for Operable Unit 1335, Southwest Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), March 1996b. "Sitewide Hydrogeologic Characterization Project, Calendar Year 1995, Annual Report" Sandia National Laboratories, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), June 1997. Bullets of understanding between NMED/DOE OB and DOE/SNL ER Project for sampling and analyses plans for ER Sites 14 and 85, OU 1335, Southwest Test Area, Sandia National Laboratories, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1997. "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico," SAND97-2320/1/2-UC-902, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998. "RESRAD Input Parameter Assumptions and Justification," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 1998. "Proposals for No Further Action Environmental Restoration Project," Environmental Restoration Project, Vol. 2, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM) and Inhalation Toxicology Research Institute (ITRI), April 1988. "U.S. DOE Environment, Safety and Health, Office of Environmental Audit Environmental Survey Preliminary Report," Sandia National Laboratories, Albuquerque, New Mexico.

SNL/NM, see Sandia National Laboratories/New Mexico.

U.S. Department of Energy (DOE), Albuquerque Operations Office, Environmental Safety and Health Division, Environmental Program Branch, September 1987, draft. "Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1: Installation Assessment, Sandia National Laboratories, Albuquerque," Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico.

U.S. Department of Energy and U.S. Air Force (DOE and USAF), March 1996. "Workbook: Future Use Management Area 7," prepared by Future Use Logistics and Support Working Group in cooperation with the Department of Energy Affiliates and the U.S. Air Force, Albuquerque, New Mexico.

U.S. Department of Energy (DOE), Kirtland Area Office, March 1996. "Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/ New Mexico," Kirtland Area Office, U.S. Department of Energy, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., Update III, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico," Contract No. 68-01-7038, Region 6, U.S. Environmental Protection Agency, Dallas, Texas.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," RCRA Permits Management Program, Hazardous and Radioactive Materials Bureau, and New Mexico Environment Department, Santa Fe, New Mexico.

Young, M. (SNL/NM). Interview conducted for the Environmental Restoration Project, Department 7585, ER/6134/1335/85/INT/96-211 or ER/7585/1335/85/INT/95-200, Sandia National Laboratories, Albuquerque, New Mexico. January 11, 1996.

Young, M., and Wrightson, S. (SNL/NM). Interview conducted for the Environmental Restoration Project, Department 7585, ER/7585/1335/55/95-81, Sandia National Laboratories, Albuquerque, New Mexico. April 4, 1995.

ANNEX 10-D
Risk Screening Assessment

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SWMU 85: RISK SCREENING ASSESSMENT

I. Site Description and History

Solid waste management unit (SWMU) 85 – Firing Site (Building 9920) is located in the Southwest Test Area in the southern part of Kirtland Air Force Base (KAFB), approximately 2.3 miles north of the Isleta Pueblo boundary and 1.3 miles west of Lovelace Road. The site consists of four small separate firing sites west, north, and south of Building 9920 that are included in the draft Operable Unit 1335 Work Plan. The immediate area slopes gently to the west and is graded and clear of vegetation. The surrounding land is covered by desert grasses and cacti.

Four firing site/test areas are associated with SWMU 85. Explosives were limited to 50 pounds or less during testing. Building 9920 was the control room for the firing sites. Firing Site 1 is located immediately west of Building 9920. It is defined by a 20- by 30-foot area adjacent to the building and by a smaller 10- by 10-foot area northwest of the building. Firing Site 2 is a series of tanks and pressure vessels located about 140 feet west of Building 9920. Firing Site 3 is the former location of an inflatable building. The site underwent a risk analysis in September 1997. Firing Site 4 is the location of the Cable Suspension Facility located approximately 1,300 feet northwest of Building 9920.

Firing Site 1 is comprised of six small pits excavated to a depth of 6 to 8 feet. Beryllium disks (approximately 100 grams total) were placed in the pits, and an explosive charge was placed on top of the disks and detonated, propelling the beryllium downward. It is believed that the pit openings were plugged with concrete before the firing tests were conducted. After each test, the pits were covered with approximately 6 inches of soil and were ultimately backfilled.

Firing Site 2 is associated with tests conducted in the late 1970s simulating reactor core meltdown scenarios by submerging molten core material into a large tank (VGES tank) containing water, and observing the reaction. The simulated core material, called corium thermite, was comprised of an alloy of zirconium, nickel oxide, chromium oxide, iron oxide, molybdenum oxide and about 40 kilograms (kg) of depleted uranium (DU). These tests contaminated the soil around the VGES Tank. The core material was deposited in the area and the water was pumped onto the ground. The area was later graded.

An aerosol experiment using 100 grams of cesium iodide was also performed in a tank. This tank was vacuumed afterwards, and approximately 90 percent of the cesium iodide was recovered.

Other types of tests conducted on the surface at either Firing Site 1 or Firing Site 2 involved blowing up small disks of cadmium sulfide (100 grams total), dispersion tests using 10,000 to 11,000 grams of manganese dioxide per shot, and tests using lithium hydride shots of an unknown mass. The specific locations of these tests are unclear but are believed to be in the general areas of Firing Sites 1 and 2.

Firing Site 3 occupies the area known as the "old air building," which was an inflatable building. A series of eight dispersion tests were conducted within the building. Each test involved a charge of 47 to 220 grams of DU powder and 0.5 pound of Composition 4 high explosives (HE). The charge was detonated to study the dispersion of DU while the building trapped the emissions. Plastic sheeting was placed on the unpaved floor of the building to capture the dispersed DU. After the test, aerosolized uranium was allowed to settle onto the plastic, which was then rolled up and disposed of in the mixed waste landfill. The inflatable building has since been removed from the site.

The first test program conducted at the Cable Suspension Facility, Firing Site 4, was the SSAGE-2 tests series. A sphere containing approximately 220 grams of DU was detonated using 0.5 pound of C-4 HE. The sphere fragmented into large pieces rather than aerosolizing as planned. Site personnel recovered about 100 grams of the 220 grams of DU from this test. According to site personnel this was the only DU experiment conducted at this facility. Approximately 50 to 100 pounds of baratol, which contains barium nitrate were used in some of the tests at this location. The barium oxide dispersed by the explosion was dispersed into the area and was deposited on the soil in the vicinity of the test area.

Most recent testing primarily involved shock-wave experiments using air detonations of hydrogen. Methyl acetylene-propene-propadiene (MAPP) gas and bromofluoromethane were also used. These tests were performed in the structure (flame pad) immediately west of Firing Site 2. Since the explosives were gases, no residual material remained in the environment. Therefore, the flame pad was not investigated.

II. Comparison of Results to Data Quality Objectives

The confirmatory sampling conducted at SWMU 85 was designed to collect adequate samples in order to:

- Determine whether hazardous waste or hazardous constituents have been released at the site
- Characterize the nature and extent of any releases
- Provide sufficient Level 3 analytical data to support risk screening assessments.

Table 1 summarizes the sample location design for SWMU 85. The source of potential constituents of concern (COC) at SWMU 85 may have been due to explosives tests both on the surface and below ground.

Eight boreholes and 41 surface soil samples including duplicates were collected at SWMU 85. Five of the eight boreholes were sampled as screening scamples. The three remaining boreholes and the 41 surface soil samples were confirmatory samples at Level III data quality. The number and location of the samples collected were dependent upon the location and nature of the firing tests performed at SWMU 85.

Table 2 summarizes the analytical methods and data quality requirements necessary (1) to determine whether hazardous waste or hazardous constituents have been released at the site, (2) to characterize the nature and extent of any releases, and (3) provide sufficient Level 3 analytical data to support risk screening assessments.

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 85	Potential COC Source	Area of Site (acres)	Number of sampling locations	Sample Density/ Acre	Sampling Location Rationale
Firing Site 1	Debris from subsurface and surface firing tests	0.05	15 surface and 9 subsurface (including duplicates) 3 boreholes (excluding scoping samples)	300	To confirm release of COCs to the environment from firing tests
Firing Site 2	Residue from surface firing tests and releases from VGES tank	0.05	11 surface samples (including duplicates)	220	To confirm release of COCs to the environment
Firing Site 3	Residue from surface firing test (release from air building)	0.1	6 surface samples (including duplicates)	60	To confirm release of COCs to the environment
Firing Site 4	Residue from surface firing test	11	9 surface samples (including duplicates) focused on the center of firing site	0.8	To confirm release of COCs to the environment

SWMU = Solid waste management unit.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	LAS and GEL	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM
RCRA metals plus beryllium EPA Method 6010/7000[a]	Level 3	50 samples including 8 duplicates	Not applicable
HE compounds EPA Method 8330[a]	Level 3	50 samples including 8 duplicates	Not applicable
Gamma Spectroscopy	Level 2	Not applicable	53 samples 8 duplicates

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
GEL = General Engineering Laboratory.
HE = High explosive.
LAS = Lockheed Analytical Services.
RCRA = Resource Conservation and Recovery Act.
SNL/NM = Sandia National Laboratories/New Mexico.

A total of 25 locations were sampled at SWMU 85 and analyzed by Sandia National Laboratories/New Mexico (SNL/NM) on-site laboratories. Twenty percent of the samples were sent off site for verification analyses for both Resource Conservation and Recovery Act (RCRA) metals plus beryllium and HE. The method detection limits (MDL) for both on-and off-site analyses were below the background concentration limits for RCRA metals plus beryllium, with only one exception. The MDL used by the off-site laboratory for analysis of some samples for mercury slightly exceeded the <0.1 milligrams per kilogram (mg/kg) background concentration limit.

All gamma spectroscopy data were review by SNL/NM Department 7713 (Radiation Protection Sample Diagnostic Laboratory) according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No: 02 (SNL/NM July 1996). In addition, all off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994). The reviews performed confirmed that the data are acceptable for use in the no further action (NFA) proposal for SWMU 85. The data quality objectives for SWMU 85 have been met.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 85 was based upon an initial conceptual model validated by confirmatory sampling at the site. The initial conceptual model was developed from historical background information including numerous site inspections, personal interviews, historical photographs, and geophysical and radiological surveys. The data quality objectives (DQO) are contained in the Operable Unit 1335 RCRA Facility Investigation (RFI) Work Plan (SNL/NM March 1996), which was modified in accordance to an agreement between New Mexico Environmental Department (NMED) and SNL/NM Department 6685 (SNL/NM June 1997). The DQOs contained in the RFI work plan identified the sample locations, sample density, sample depth, and analytical requirements. The sample data subsequently used to characterize SWMU 85 were collected in accordance with the rationale and procedures described in the Bullets of Understanding between NMED/DOE OB and DOE/SNL ER (June 11, 1997). The data were subsequently used to develop the final conceptual model for SWMU 85, which is presented in Section 10.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination are described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 85 was determined with analytical testing of soil media and the potential for degradation of relevant COCs (Section V). The analytical requirements included RCRA metals plus beryllium, nickel, and mercury to characterize inorganic contamination in the soil. Gamma spectroscopy was used as a general screening analyses and to determine if radiological contaminated soil from SWMU 85. Explosives analyses were performed on the soil samples to determine if explosive residue from the firing testing was present in the soils. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with historical activities at SWMU 85.

III.3 Rate of Contaminant Migration

The rate of COC migration is dependent predominantly on site meteorological and surface hydrologic processes as described in Section V. Data available from the Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface-water, radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the Kirtland Air Force Base (KAFB) (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COC migration at SWMU 85.

III.4 Extent of Contamination

Several constituents were identified at SWMU 85. These include arsenic, barium, chromium, nickel, lead, and silver, HMX, and the radiological constituents U-238 and U-235. Mercury, selenium, and cadmium do not have quantified maximum background screening levels, therefore, it is not not known whether these constituents exceed background. The surface anomalies at Firing Site 3 (silver) and Firing Site 4 (Ba and U-238) appear to be local variations in the soil quality although one sample at Firing Site 4 showed a low concentration of HMX.

The vertical of contamination at two of the firing sites is defined by the subsurface samples collected from Firing Site 1 and the trench samples from Firing Site 2 (SWMU 14).

The nature and extent of contamination is discussed in greater detail in Section II.5.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, rate, and extent of contamination.

IV. Comparison of Constituents of Concern to Background Screening Levels

Site history and characterization activities are used to identify potential constituents of concern (COC). The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the SWMU 85 No Further Action (NFA) Proposal. Generally, COCs evaluated in this risk assessment include all detected organics and radioactive contaminants and all inorganic COCs that were analyzed for. Nondetect organics that were not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. If the detection limit of an organic compound was too high (could possibly cause an adverse effect to human health or the environment), the compound was retained. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. The approved Sandia National Laboratories, New Mexico (SNL/NM) maximum background concentration (Dinwiddie September 1997) was selected to provide the background screen in Tables 3, 4, 5, and 6. Human health nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 3) (IT July 1994).

Chemicals such as iron, magnesium, calcium, potassium, and sodium that are essential nutrients were not included in this risk assessment (EPA 1989). Both radiological and

Table 3
Nonradiological COCs for Human Health Risk Assessment at SWMU 85 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow} and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow}	Bioaccumulator?[b] (BCF>40, log K_{ow}>4)	Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	4.6	4.4	No	44[d]	NA	Yes	0.5	No
Barium	400	130	No	170[e]	NA	Yes	6000	Yes
Beryllium	0.583	0.65	Yes	19[d]	NA	No	0.2	No
Cadmium	0.399 J	<1	Unknown	64[d]	NA	Yes	80	Yes
Chromium, total[f]	23 J	15.9	No	16[d]	NA	No	400	Yes
Lead	380 PJ	11.8	No	49[d]	NA	Yes	--	--
Mercury	0.0165 J	<0.1	Unknown	5500[d]	NA	Yes	20	Yes
Nickel	38	11.5	No	47[d]	NA	Yes	2000	Yes
Selenium	0.81 J	<1	Unknown	800[g]	NA	Yes	400	Yes
Silver	3	<1	No	0.5[d]	NA	No	400	Yes
HMX	8.4	NA	NA	--	0.26[h]	No	--	--

[a]From Dinwiddie (September 1997), Southwest Test Area.
[b]From NMED (March 1998).
[c]From IT (1994).
[d]BCF and/or Log K_{ow} from Yanicak (March 1997).
[e]BCF from Neumann (1976).
[f]Assumed to be chromium VI for Subpart S screening procedure.
[g]Bioconcentration factor from Callahan et al. (1979).
[h]Log K_{ow} from Maxwell and Opresko (1996).

BCF = Bioconcentration factor.
COC = Constituent of concern.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environment Department.
PJ = Laboratory precision measurements do not meet acceptance criteria.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
-- = Information not available.

Table 4
Nonradiological COCs for Ecological Risk Assessment at SWMU 85 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow}	Bioaccumulator? (BCF>40, Log K_{ow}>4)
Arsenic	3.94	4.4	Yes	44[b]	NA	Yes
Barium	400	130	No	170[c]	NA	Yes
Beryllium	0.583	0.65	Yes	19[b]	NA	No
Cadmium	0.399 J	<1	Unknown	64[b]	NA	Yes
Chromium, total	23 J	15.9	No	16[b]	NA	No
Lead	380 PJ	11.8	No	49[b]	NA	Yes
Mercury	0.0165 J	<0.1	Unknown	5500[b]	NA	Yes
Nickel	38	11.5	No	47[b]	NA	Yes
Selenium	0.81 J	<1	Unknown	800[d]	NA	Yes
Silver	3	<1	No	0.5[b]	NA	No
HMX	8.4	NA	NA	--	0.26[e]	No

[a]From Dinwiddie (September 1997), Southwest Test Area.
[b]BCF from Yanicak (1997).
[c]BCF from Neumann (1976).
[d]BCF from Callahan et al. (1979).
[e]Log K_{ow} from Maxwell and Oresko (1996).

BCF = Bioconcentration factor.
COC = Constituent of concern.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
PJ = Laboratory precision measurements do not meet acceptance criteria.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
-- = Information not available.

Table 5
Radiological COCs for Human Health Risk Assessment at SWMU 85 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF[b] (maximum aquatic)	Bioaccumulator?[b] (BCF>40, Log K_{ow}>4)
Cs-137	0.36	0.66	Yes	3000	Yes
Th-232	0.95	1.01	Yes	Not bioconcentrator	No
U-234[c]	3.3	1.6	**No**	900[d]	Yes
U-235	0.54	0.16	**No**	900[d]	Yes
U-238	26.7	1.4	**No**	900[d]	Yes

[a]From Dinwiddie (September 1997), Southwest Test Area.
[b]BCF from Yanicak (March 1997).
[c]U-234 value was calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/8 (Miller June 1998).
[d]BCF from Baker and Soldat (1992).

BCF = Bioconcentration factor.
COC = Constituent of concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
-- = Information not available.

Table 6
Radiological COCs for Ecological Risk Assessment at SWMU 85 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF[b] (maximum aquatic)	Bioaccumulator?[b] (BCF>40, Log K_{ow}>4)
Cs-137	0.36	0.66	Yes	3000	Yes
Th-232	0.96	1.01	Yes	Not bioconcentrator	No
U-234[c]	3.3	1.6	**No**	900[d]	Yes
U-235	0.54	0.16	**No**	900	Yes
U-238	26.7	1.4	**No**	900	Yes

[a]From Dinwiddie (September 1997), Southwest Test Area.
[b]BCF from Yanicak (March 1997).
[c]U-234 value was calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/8 (Miller June 1998).
[d]BCF from Baker and Soldat (1992).

BCF = Bioconcentration factor.
COC = Constituent of concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.

nonradiological COCs are evaluated. The nonradiological COCs evaluated in this risk assessment include inorganics and all high explosives were reported as nondetect.

Table 3 lists the Nonradiological COCs for Human Health Risk Assessment at SWMU 85; Table 4 lists nonradiological COCs for Ecological Risk Assessment. Tables 5 and 6 list Radiological COCs. All tables show the associated approved SNL/NM background concentration values (Dinwiddie September 1997). Discussion of Tables 3 and 5 is provided in Section VI.4. Discussion of Tables 4 and 6 is provided in Section VII.2.

V. Fate and Transport

The primary release of COCs at SWMU 85 was to the surface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Excavation and removal of soil are potential human-caused mechanisms of transport. Winds can be strong in the open, grassland environment at SWMU 85. Moderate winds can transport soil particles with adsorbed COCs (or COCs in particulate form) as suspended dust, capable of dry or wet deposition. Strong winds may move larger (sand-sized) particles by saltation. Wind erosion is reduced by vegetative cover; however, this site does not have a good vegetative cover.

Water at SWMU 85 is received as precipitation (rain or occasionally snow). The average annual precipitation in this area is about 8 inches (NOAA 1990) and the evapotranspiration value is 95 percent of the total rainfall (Thomson and Smith 1985). Precipitation will either infiltrate or form runoff. Infiltration at the site is enhanced by the nearly flat relief and the sandy nature of the soil (the soil in the area of the site is primarily Tijeras gravelly fine sandy loam [USDA June 1977]). Runoff from the site is probably only significant during intense rainfall events and during extended rainfall periods when soils are near saturation from previous rainfall. Surface runoff in the area of SWMU 85 is to the west, toward an internal drainage basin, but no major surface drainage features occur on the site. Runoff may carry soil particles with adsorbed COCs. The distance of transport will depend on the size of the particle and the velocity of the water (which will generally be low because of the flat terrain).

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution may be leached into the subsurface soil with this percolation. The effective rooting depths of the soil at SWMU 85 is about 60 inches [USDA 1977], indicating the depth of the system's transient water cycling zone (the dynamic balance between percolation/infiltration and evapotranspiration). Because groundwater at this site is approximately 347 feet below ground surface (bgs), the potential for COCs to reach groundwater through the unsaturated zone above the watertable is very small. As water from the surface evaporates, the direction of COC movement may be reversed with capillary rise of the soil water.

Plant roots can take up COCs that are in the soil solution. Although this may be a passive process, active uptake (i.e., requiring energy expediture on the part of the plant) or exclusion of some constituents in the soil solution may also take place. COCs taken up by the roots may be transported to the aboveground tissues with the xylem stream. Aboveground tissues can take up adsorbed constituents by contact with dust particles. COCs in the tissue may be consumed by herbivores or eventually returned to the soil as litter. Aboveground litter is capable of transport by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores may pass through the gut and returned to the soil in feces (at the site or transported from the site in the herbivore), or absorbed to be held in tissues, metabolized, or excreted. The herbivore may be eaten by a primary carnivore or scavenger and the constituent still held in the consumed tissues will repeat the sequence of absorption, metabolization, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain is dependent upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain.

The COCs at SWMU 85 that are inorganic and elemental in form are not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Transformations of inorganics may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms. HMX (the only organic COC) is persistant in the environment, but undergoes rapid biotransformation in biota (Maxwell and Opresko 1996).

Table 7 summarizes the fate and transport processes that may occur at SWMU 85. COCs at this site are primarily inorganics (metals and DU) in surface soil. Because this site is disturbed, vegetative cover is low. Therefore, moderate transport of COCs by wind is possible at this site. Transport by surface-water runoff is moderated by the low slope and high infiltration of the soil. Significant leaching into the subsoil is unlikely for most inorganics, and leaching to the groundwater at this site is highly unlikely. The potential for uptake into the food chain is low. Degradation of the inorganic COCs and decay of radiological COCs is expected to be insignificant. Biotransformation of HMX is expected to be significant.

Table 7
Summary of Fate and Transport at SWMU 85

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Moderate
Surface runoff	Yes	Low
Migration to groundwater	No	None
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low (inorganics and radionuclides) Moderate to high (HMX)

SWMU = Solid waste management unit.

VI. Human Health Risk Assessment Analysis

VI.1 Introduction

Human health risk assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include the following:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.

Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an approved SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that are not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and DOE to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties are discussed in the previous steps.

VI.2 Step 1. Site Data

Section I provides the description and history for SWMU 85. Section II provides a comparison of results to DQOs. Section III provides the determination of the nature, rate and extent of contamination.

VI.3 *Step 2. Pathway Identification*

SWMU 85 has been designated a future land-use scenario of industrial (DOE and USAF March 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and, for the radiological COCs, direct gamma exposure. The inhalation pathway for nonradiological COCs is included because of the potential to inhale dust and volatiles for the nonradiological COCs and dust only for the radiological COCs. Soil ingestion is included for the radiological COCs as well. No contamination at depth was determined, and therefore no water pathways to the groundwater are considered. Depth to groundwater at SWMU 85 is approximately 347 feet bgs. *Because of the lack of surface water or other significant mechanisms for dermal contact,* the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Nonradiological Constituents	*Radiological Constituents*
Soil Ingestion	Soil Ingestion
Inhalation (dust and volatiles)	Inhalation (dust)
Plant Uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

This section discusses Step 3. This step includes the discussion of two screening procedures. The first screening procedure is a comparison of the maximum COC concentration to the approved background screening level. The second screening procedure compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure is only applied to COCs that are not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of COCs were compared to the approved SNL/NM maximum screening level for this area (Dinwiddie September 1997). The approved SNL/NM maximum background concentration was selected to provide the background screen in Table 3 and to be used to calculate risk attributable to background in Table 11. Only the COCs that were above their respective SNL/NM background screening level or COCs that did not have a quantifiable background screening level, were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

Comparison of SWMU 85 data to SNL/NM approved background values (Dinwiddie September 1997) for Human Health risk assessment is presented in Tables 3 and 5. For the nonradiological COCs, six constituents had maximum measured values greater than their respective background screening levels. Three nonradiological COCs did not have quantifiable background concentrations, so it is unknown whether those COCs exceeded background. HMX does not have a background concentration.

The maximum concentration value for lead is 380 PJ milligrams per kilogram (mg/kg). The EPA intentionally does not provide any human health toxicological data on lead, and therefore, no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA July 1994). The maximum concentration value for lead at this site is less than both screening values, and therefore, lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, three constituents had maximum activities greater than their respective background (U-234, U-235, and U-238). These radiological constituents were evaluated using the RESRAD code.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs that were not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there were more than ten COCs, the Subpart S screening procedure was eliminated.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA (1996a). One COC that failed the initial background screening was above its respective proposed Subpart S action level. Two COCs do not have calculated Subpart S Action Levels. Because of these COCs, the site fails the Subpart S screening criteria and a hazard quotient and excess cancer risk value must be calculated for all the COCs.

Radiological COCs do not have predetermined action levels analogous to proposed Subpart S levels, and therefore this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 8 (nonradiological) and 9 (radiological) show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. The toxicological values used in Table 8 are from the Integrated Risk Information System (IRIS) (EPA 1998a), Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), and EPA Region 9 (EPA 1996b) and Region 3 (EPA 1997b) databases. Dose conversion factors (DCF) used in determining the excess TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following documents:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).

Table 8
Toxicological Parameter Values for SWMU 85 Nonradiological COCs

COC Name	RfD_o (mg/kg-day)	Confidence[a]	RfD_{inh} (mg/kg-day)	Confidence[a]	SF_o (mg/kg-day)$^{-1}$	SF_{inh} (mg/kg-day)$^{-1}$	Cancer Class[b]
Arsenic	3E-4[c]	M	--	--	1.5E+0[c]	1.5E+1[c]	A
Barium	7E-2[c]	M	1.4E-4[d]	--	--	--	--
Cadmium	5E-4[c]	H	5.7E-5[d]	--	--	6.3E+0[c]	B1
Chromium III	1E+0[c]	L	5.7E-7[e]	--	--	--	--
Chromium VI	5E-3[c]	L	--	--	--	4.2E+1[c]	A
Mercury	3E-4[f]	--	8.6E-5[c]	M	--	--	D
Nickel	2E-2[c]	M	--	--	--	--	--
Selenium	5E-3[c]	H	--	--	--	--	D
Silver	5E-3[c]	L	--	--	--	--	D
HMX	5E-2[c]	L	5E-2[d]	--	--	--	D

[a]Confidence associated with IRIS (EPA 1998a) database values. Confidence: L = low, M = medium, H = high.

[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a):

A - Human carcinogen.
B1 - Probable human carcinogen. Limited human data are available.
B2 - Probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
D - Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 1998a).
[d]Toxicological parameter values from EPA Region 9 electronic database (EPA 1996b).
[e]Toxicological parameter values from EPA Region 3 electronic database (EPA 1997b).
[f]Toxicological parameter values from HEAST database (EPA 1997a).

COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-day = Milligram(s) per kilogram day.
(mg/kg-day)$^{-1}$ = Per milligram per kilogram day.
RfD_o = Oral chronic reference dose.
RfD_{inh} = Inhalation chronic reference dose.
SF_o = Oral slope factor.
SF_{inh} = Inhalation slope factor.
SWMU = Solid waste management unit.
-- = Information not available.

Table 9
Radiological Toxicological Parameter Values for SWMU 85 COCs Obtained from RESRAD Risk Coefficients[a]

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
U-238	6.20E-11	1.20E-08	6.60E-08	A
U-235	4.70E-11	1.30E-08	2.70E-07	A
U-234	4.40E-11	1.40E-08	2.10E-11	A

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A - human carcinogen.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
SF_o = Oral (ingestion) slope factor.
SF_{inh} = Inhalation slope factor.
SF_{ev} = External volume exposure slope factor.
1/pCi = One per picocurie.
g/pCi-yr = Gram(s) per picocurie-year.
SWMU = Solid waste management unit.

- The DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (*Health Physics* 28:193-205) (Kocher 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993a).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI value and the excess cancer risk, for both the potential nonradiological COCs and associated background for industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land-uses.

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in the calculation of intake values and the subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations for nonradiological COCs are based upon RAGS (EPA 1989). The parameters are based upon information from RAGS (EPA 1989) as well as other EPA guidance documents and reflect the Reasonable Maximum Exposure (RME) approach advocated by RAGS (EPA 1989). For radiological COCs, the coded equations provided in the RESRAD computer code were used to estimate the incremental TEDE and cancer risk for the individual exposure pathways. Further discussion of this process is provided in *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0 (Yu et al. 1993a).

Although the designated land use scenario is industrial for this site, the risk and TEDE values for a residential land use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of the potential for risk to human health under the more restrictive land use scenario.

VI.6.2 Risk Characterization

Table 10 shows that for the SWMU 85 nonradiological COCs, the HI value is 0.03, and the excess cancer risk is 2E-6 for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for the nonradiological COCs. Table 11 shows that assuming the maximum background concentrations of the SWMU 85 associated background constituents, the HI is 0.01, and the excess cancer risk is 2E-6 for the designated industrial land-use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land-use scenario, a TEDE was calculated for an industrial office worker who spends a majority of his time indoors and for an industrial worker who evenly splits his time indoors and outdoors on the site. After analyzing these two scenarios, the most conservative is the 50/50 time split. For this industrial land-use scenario, an incremental TEDE of 7.4E-1 millirem per year (mrem/yr) results. In accordance with EPA guidance found in OSWER Directive No.9200.4-18 (EPA 1997c), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 85 for the industrial land use is well below this guideline. The estimated excess cancer risk is 8.3E-6.

For the residential land-use scenario nonradioactive COCs, the HI value increases to 1, and the excess cancer risk is 5E-5 (Table 10). The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 11 shows that for the SWMU 85 associated background constituents, the HI is 0.3, and the excess cancer risk is 5E-5.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 2.1 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 85 for the residential land-use is well below this guideline. Consequently, SWMU 85 is eligible for unrestricted radiological release as the residential land-use scenario resulted in an incremental TEDE to the on-site receptor of less than 75 mrem/yr. The estimated excess cancer risk is 2.6E-5. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in RAGS (EPA 1989).

Table 10
Risk Assessment Values for SWMU 85 Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Industrial Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		HI	Cancer Risk	HI	Cancer Risk
Arsenic	4.6	0.02	2E-6	0.26	5E-5
Barium	400	0.01	--	0.06	--
Cadmium	0.399 J	0.00	1E-10	0.33	2E-10
Chromium, total[b]	23 J	0.00	5E-8	0.02	9E-8
Mercury	0.0165 J	0.00	--	0.03	--
Nickel	38	0.00	--	0.06	--
Selenium	0.81 J	0.00	--	0.28	--
Silver	3	0.00	--	0.12	--
HMX	8.4	0.00	--	0.00	--
TOTAL		**0.03**	**2E-6**	**1**	**5E-5**

[a]EPA (1989).
[b]Chromium, total is assumed to be chromium VI (most conservative).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
HI = Hazard index.
J = Estimated concentration.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid waste management unit.
-- = Information not available.

Table 11
Risk Assessment Values for SWMU 85 Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Industrial Land-Use Scenario[b]		Residential Land-Use Scenario[b]	
		HI	Cancer Risk	HI	Cancer Risk
Arsenic	4.4	0.01	2E-6	0.25	5E-5
Barium	130	0.00	--	0.02	--
Cadmium	<1	--	--	--	--
Chromium, total[c]	15.9	0.00	--	0.01	--
Mercury	<0.1	--	--	--	--
Nickel	11.5	0.00	--	0.02	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
					--
TOTAL		**0.01**	**2E-6**	**0.3**	**5E-5**

[a]From Dinwiddie (September 1997), Southwest Test Area.
[b]EPA (1989).
[c]Chromium, total is assumed to be chromium III (most conservative).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
HI = Hazard index.
J = Estimated concentration.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid waste management unit.
-- = Information not available.

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario (the designated land-use scenario for this site) and a residential land-use scenario.

For the industrial land-use scenario nonradiological COCs, the calculated HI is 0.03 which is significantly less than the numerical guideline of 1 suggested in RAGS (EPA 1989). The excess cancer risk is estimated at 2E-6. Guidance from the New Mexico Environment Department (NMED) indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED 1998). The excess cancer risk is driven by arsenic which is a Class A carcinogen. Thus, the total excess cancer risk for this site is above the suggested acceptable risk value of 1E-6. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For nonradiological COCs, assuming the industrial land-use scenario, the HI is 0.01. The excess cancer risk is estimated at 2E-6. Incremental risk is determined from subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and within the text. The incremental HI is 0.02, and the incremental cancer risk is 5E-8 for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from the nonradiological COCs considering an industrial land-use scenario.

For the radiological COCs of the industrial land-use scenario, the incremental TEDE 7.4E-1 mrem/yr, which is less than EPA's numerical guideline of 15 mrem/yr. The incremental estimated excess cancer risk is 8.3E-6.

For the residential land-use scenario nonradiological COCs, the calculated HI is 1, which is at the numerical guidance. The excess cancer risk is estimated at 5E-5. The excess cancer risk is again driven by arsenic which is a Class A carcinogen. Therefore, the total excess cancer risk for this site is above suggested acceptable risk value of 1E-6. The HI for associated background for the residential land-use scenario is 0.3. The excess cancer risk is estimated at 5E-5. The incremental HI is 0.86, and the incremental cancer risk is 9E-8 for the residential land-use scenario. The incremental HI indicates insignificant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 2.1 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is 2.6E-5.

VI.8 Step 7. Uncertainty Discussion

The data used to characterize SWMU 85 were provided by 41 confirmatory, Level III surface samples including duplicates and 9 confirmatory Level III subsurface samples collected at the site. The samples were collected from areas suspected of contamination based upon process knowledge. The total area of contamination of the four sites is as follows:

- Approximately 2,350 square feet for Firing Site 1
- Approximately 2,500 square feet for Firing Site 2
- Approximately 4,700 square feet for Firing Site 3
- Approximately 11 acres for Firing Site 4.

For this size area, 41 surface samples were deemed sufficient to establish whether residues from aboveground testing were detectable. For Firing Site 1, where subsurface testing occurred, a geophysical survey was conducted to detect any subsurface geophysical anomalies indicating the potential occurrence of contaminants. No significant anomalies were delineated. For the subsurface sampling, twenty-nine samples were deemed sufficient to establish whether material from subsurface testing was detectable. The COCs for the site are primarily depleted uranium, metals, specifically chromium and beryllium, and HE residue. The soil samples were analyzed for HE using EPA Method 8330 (EPA November 1986), for the RCRA metals, including beryllium using EPA Method 6010 (EPA November 1986) and for mercury using EPA Method 7471 (EPA November 1986). Radiological activity was measured using gamma spectroscopy. Samples from BH-1, BH-2, BH-3 BH-4, and BH-5 were screening samples collected in 1995, and analyzed at SNL/NM's on-site laboratory at DV-1 and DV-II levels. The remaining samples were sent offsite to a CLP laboratory and analyzed at Level III data quality. Radiological analyses were conducted at SNL/NM's in-house laboratory. The data provided by the CLP laboratory and the onsite radiological laboratory is considered definitive data suitable for use in a risk assessment analyses. Screening sample data collected in 1995 were not considered viable data for a risk assessment because of the low level of data quality and, therefore, was not used.

Because of the location, history of the site, and future land-use (DOE and USAF March 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results.

Table 8 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998a), HEAST (EPA 1997a), EPA Region 9 (EPA 1998b) and Region 3 (EPA 1997b) databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 1998a), or the EPA regions (EPA 1996a, 1997b). Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

Incremental risk assessment values for the nonradiological COCs are within the Human Health acceptable range for the industrial land-use scenario compared to the established numerical guidance.

For the radiological COCs, the conclusion from the risk assessment is that the potential effects on human health, for both the industrial and residential land-use scenarios, are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered insignificant with respect to the conclusion reached.

VI.9 Summary

SWMU 85 has identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario, and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, inhalation of dust, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the HI of 0.03 is significantly less than the accepted numerical guidance from the EPA. The total excess cancer risk of 2E-6 is above the acceptable risk value provided by the NMED for an industrial land-use (NMED March 1998). However, the incremental HI is 0.02, and the incremental cancer risk is 5E-8 for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health for an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radiological COCs are much less than EPA guidance values; the estimated TEDE is 7.4E-1 mrem/yr for the industrial land-use scenario. This value is less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value is 8.3E-6 for the industrial land-use scenario. Furthermore, the incremental TEDE for the residential land-use scenario which results from a complete loss of institutional control is only 2.1 mrem/year with an associated risk of 2.6E-5. The guideline for this scenario is 75 mrem/year (SNL/NM February 1998). Therefore, SWMU 85 is eligible for unrestricted radiological release.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded that this site does not have potential to affect human health under an industrial land-use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPECs) in soils at SWMU 85 (Burial Site at Building 9920). A component of the NMED Risk-Based Decision Tree is to conduct an ecological screening assessment that corresponds with that presented in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in the scoping assessment (Section VII.2), with the exception of DQOs which are reviewed in Section II of this document. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. This assessment incorporates conservatisms in the estimation of ecological risks; however, ecological relevance and professional judgment are also used as recommended by the EPA (EPA 1998b) to ensure that predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A Scoping Risk Management Decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 4 and 6), constituents in soil within the 0- to 5-foot depth interval that exceeded background concentrations were as follows:

- Barium
- Cadmium
- Chromium (total)
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- HMX
- U-234
- U-235
- U-238.

VII.2.2 Bioaccumulation

Among the COCs listed in Section VII.2, the following were considered to have bioaccumulation potential in aquatic environments (Section IV):

- Barium
- Cadmium
- Lead
- Mercury
- Nickel
- Selenium.

It should be noted, however, that as directed by the NMED (NMED March 1998), bioaccumulation is exclusively assessed based upon log K_{ow} values and maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COCs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 7 (Section V), significant fate and transport may be associated with wind dispersion. Surface-water runoff is expected to be of moderate to low significance. Transformation, degradation, and food-chain uptake are expected to be of low significance for inorganics. Biotransformation of HMX will prevent food-chain uptake from being significant. Migration to groundwater is not anticipated.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.

- Exposure Estimation—provides a quantitative estimate of potential exposure.

- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.

- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.

- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.

- Risk Interpretation—evaluates ecological risk in terms of hazard quotients (HQ) and ecological significance.

- Screening Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the Screening Assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER [Environmental Restoration] Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 85 is a controlled access, active firing site located east of Technical Area III. The total area of the 4 Firing Sites is 11.2 acres. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Previous survey results (IT February 1995) show that SWMU 85 is located in a highly disturbed area essentially cleared of natural vegetation. No sensitive species were observed at the site, and none are expected to occur.

Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Depth to groundwater is approximately 347 feet but varies in the area of the site because of the complex geology. Groundwater is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

Tests conducted at SWMU 85 have included numerous explosives tests, some involving beryllium, cadmium, lead, lithium, and DU. Tests involving beryllium were conducted in covered firing pits. Although some of the beryllium was vaporized, much of it may have remained in fragments in the holes. Some cadmium-sulfide experiments were also conducted in front of the building. The site is still active. Current explosives tests are conducted on the ground surface and may release HE residues and metals. The COCs at this site include but are not limited to DU, beryllium, lead, HE, and cadmium sulfide.

This ecological risk assessment is based upon the maximum soil concentrations of the COPECs as measured in surface soil samples. Both radiological and nonradiological COPECs are evaluated. The nonradiological COPECs include both metals and HE. Inorganic analytes were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area were considered to be COPECs. HMX was the only organic analyte detected in soil and is included as a COPEC.

In order to provide conservatism in this ecological risk assessment, the exposure models use only the maximum concentration value of each COPEC determined for the entire site as measured in soil samples within the top 5 feet of soil. Both radiological and nonradiological COPECs are evaluated. The COPECs consist of metals and radionuclides that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997). Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (EPA 1989). Tables 4 and 6 report the maximum COPEC concentrations.

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. A deer mouse (*Peromyscus maniculatus*) and burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected as the top predator. It is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 12 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-235, U-238, and U-234. Internal and external dose rates to the deer mouse and burrowing owl are approximated using modified dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998). Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate caused by exposure to radionuclides in soil.

Table 13 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 14 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

Table 12
Exposure Factors for Ecological Receptors at SWMU 85

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E-2[d]	3.72E-3	Plants: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E-2[d]	3.72E-3	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	2.7E-1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E-2[d]	3.72E-3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E-1[f]	1.73E-2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
SWMU = Solid waste management unit.

Table 13
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 85

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Barium	1.5E-1[a]	1.0E+0[b]	2.0E-4[c]
Cadmium	5.5E-1[a]	6.0E-1[d]	5.5E-4[a]
Chromium (total)	4.0E-2[c]	1.3E-1[e]	3.0E-2[c]
Lead	9.0E-2[c]	4.0E-2[d]	8.0E-4[c]
Mercury	1.0E+0[c]	1.0E+0[b]	2.5E-1[a]
Nickel	2.0E-1[c]	3.8E-1[e]	6.0E-3[a]
Selenium	5.0E-1[c]	1.0E+0[b]	1.0E-1[c]
Silver	1.0E+0[c]	2.5E-1[d]	5.0E-3[c]
Organic[f]			
HMX	2.7E+1	1.4E+1	3.4E-8

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (1989).
[d]From Stafford et al. (1991).
[e]From Ma (1982).
[f]Soil-to-plant and soil-to-muscle transfer factors were obtained from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factor is from the equation developed in Connell and Markwell (1990).
NCRP = National Council on Radiation Protection and Measurements.
SWMU = Solid waste management unit.

Table 14
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 85

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Barium	4.0E+2	6.0E+1	4.0E+2	1.5E-1
Cadmium	4.0E-1	2.2E-1	2.4E-1	4.1E-4
Chromium (total)	2.3E+1	9.2E-1	3.0E+0	2.3E-1
Lead	3.8E+2	3.4E+1	1.5E+1	8.1E-2
Mercury	1.7E-2	1.7E-2	1.7E-2	1.4E-2
Nickel	3.8E+1	7.6E+0	1.4E+1	2.2E-1
Selenium	8.1E-1	4.1E-1	8.1E-1	1.3E-1
Silver	3.0E+0	3.0E+0	7.5E-1	3.0E-2
Organic				
HMX	8.4E+0	2.3E+2	1.1E+2	1.8E-5

[a]In milligrams per kilogram. All are based upon dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).
EPA = U.S. Environmental Protection Agency.
SWMU = Solid waste management unit.

VII.3.3 Ecological Effects Evaluation

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 15. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species.

Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs for terrestrial plant life and wildlife receptors, respectively.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad per day should also offer sufficient protection to other components within the terrestrial habitat of SWMU 85.

VII.3.4 Risk Characterization

Maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 16. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

Analytes with HQs exceeding unity for plants were chromium (total), lead, nickel, and silver. Two analytes, barium and HMX, resulted in HQs greater than 1.0 for all three modeled diets of the deer mouse (i.e., herbivorous, omnivorous, and insectivorous). No ecological risk was predicted for the burrowing owl, although HQs for the burrowing owl could not be determined for silver and HMX. As directed by the NMED, HIs were calculated for each of the receptors. The HI is the sum of chemical specific hazard quotients for all pathways for a given receptor. All ecological receptors had HIs greater than unity except for the owl

Tables 17 and 18 summarize the internal and external dose rate model results for the three radionuclides. The total radiation dose rate to the deer mouse was predicted to be 3.8E-4 rad/day. The total dose rate to the burrowing owl was predicted to be 1.9E-4 rad/day. The internal dose rate from exposure to these radionuclides is the primary contributor to the total dose rate in the deer mouse; whereas, the external and internal dose rates were approximately the same in the burrowing owl. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 85. These uncertainties result in the use of assumptions in estimating risk that may lead to an overestimation or underestimation of the true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk

Table 15
Toxicity Benchmarks for Ecological Receptors at SWMU 85

		Mammalian NOAELs			Avian NOAELs		
Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[e,g]
Inorganic							
Barium	500	Rat[h]	5.1	10.5	Chicks	20.8	20.8
Cadmium	3	Rat[i]	1.0	1.9	Mallard	1.45	1.45
Chromium (total)	1	Rat	2,737	5,354	Black duck	1.0	1.0
Lead	50	Rat	8.0	15.7	American kestrel	3.85	3.85
Mercury (inorganic)	0.3	Mouse	13.2	14.0	Japanese Quail	0.45	0.045
Mercury (organic)	0.3	Rat	0.032	0.063	Mallard	0.0064	0.0064
Nickel	30	Rat	40	78	Mallard	77.4	77.4
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8	34.8	---[j]	---	---
Organic							
HMX	---	Mouse[k,l]	3.0[k]	3.0	---	---	---

[a]In milligrams per kilogram soil.
[b]From Will and Suter (1995), except where noted.
[c]Body weights (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[d]From Sample et al. (1996), except where noted.
[e]In milligrams per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.435 kilogram.
[i]Body weight: 0.303 kilogram.
[j]--- designates insufficient toxicity data.
[k]From Maxwell and Opresko (1996).
[l]Body weight: 0.023 kilogram.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
SWMU = Solid waste management unit.

Table 16
Hazard Quotients for Ecological Receptors at SWMU 85

Constituent of Potential Ecological Concern	Plant HQ[a]	Deer Mouse HQ (Herbivorous)[a]	Deer Mouse HQ (Omnivorous)[a]	Deer Mouse HQ (Insectivorous)[a]	Burrowing Owl HQ
Inorganic					
Barium	8.0E-1	**1.0E+0**	**3.5E+0**	**6.0E+0**	4.4E-2
Cadmium	1.3E-1	1.9E-2	2.0E-2	2.1E-2	6.5E-4
Chromium (total)	**2.3E+1**	4.0E-5	7.0E-5	1.0E-4	7.7E-2
Lead	**7.6E+0**	4.2E-1	3.2E-1	2.3E-1	2.2E-1
Mercury (inorganic)	5.7E-2	1.9E-4	1.9E-4	1.9E-4	3.4E-3
Mercury (organic)	5.7E-2	4.3E-2	4.3E-2	4.3E-2	2.4E-1
Nickel	**1.3E+0**	1.7E-2	2.3E-2	3.0E-2	1.4E-3
Selenium	4.1E-1	1.7E-1	2.5E-1	3.3E-1	5.4E-2
Silver	**1.5E+0**	1.4E-2	8.7E-3	3.6E-3	---
Organic					
HMX	---	**1.2E+1**	**9.0E+0**	**6.0E+0**	---
HI[c]	**3.5E+1**	**1.4E+1**	**1.3E+1**	**1.3E+1**	6.4E-1

[a]**Bold** text indicates HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs. Using the value for organic mercury as a conservative estimate of the HI.

HI = Hazard index.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
HQ = Hazard quotient.
SWMU = Solid waste management unit.
--- = Designates insufficient toxicity data available for risk estimation purposes.

Table 17
Internal and External Dose Rates for Deer Mice Exposed to Radionuclides at SWMU 85, Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-234[a]	3.3E+0	3.8E-5	3.7E-7	3.9E-5
U-235	5.4E-1	5.9E-6	8.8E-6	1.5E-5
U-238	2.7E+1	2.6E-4	5.4E-5	3.3E-4
Total		3.1E-4	6.3E-5	3.8E-4

[a]The U-234 value was calculated using the U-238 concentration and assuming that the U-238-to-U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/78 (Miller June 1998).
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

Table 18
Internal and External Dose Rates for Burrowing Owls Exposed to Radionuclides at SWMU 85, Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-234[a]	3.3E+0	1.5E-5	3.7E-7	1.6E-5
U-235	5.4E-1	2.4E-6	8.8E-6	1.1E-5
U-238	2.7E+1	1.1E-4	5.4E-5	1.6E-4
Total		1.3E-4	6.3E-5	1.9E-4

[a]The U-234 value was calculated using the U-238 concentration and assuming that the U-238-to-U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/78 (Miller June 1998).
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

assessment include the use of the maximum measured analyte concentrations to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the use of earthworm-based transfer factors for modeling COPECs into soil invertebrates in the absence of insect data, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties which are consistent among each of the ER specific ecological risk assessments is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the Sandia National Laboratories ER Program (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-234, U-235, and U-238 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors, which are typically negligible. The dose rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's exposure to radionuclides in soil, both internally and externally.

One large uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured soil concentrations to evaluate risk. This results in a conservative scenario that does not necessarily reflect actual site conditions. The assumption of an area use factor of 1.0 is a source of uncertainty for the burrowing owl. Exposure is likely overestimated for this receptor.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Table 19 illustrates risk estimates associated with exposure of each of the receptors to background concentrations of the metal COPECs. With respect to the plant, an HQ greater than one was obtained for chromium (total). Almost 70 percent of the on-site maximum total chromium concentration was associated with background. HQs greater than unity were also obtained for the omnivorous and insectivorous deer mouse exposed to barium. Almost 33 percent of the on-site maximum barium soil concentration was associated with background. Because of the uncertainties associated with exposure and toxicity, it is unlikely that barium and chromium, with exposure concentrations largely attributable to background, present a significant ecological risk.

Chromium, lead, nickel, and silver were predicted hazardous to plants based upon exposure to maximum soil concentrations. Chromium was detected in 82 percent of the samples collected. Detected concentrations ranged from 5.1 to 23 mg/kg with an average detected concentration of 9.1 mg/kg. Exposure of plants to the overall average chromium concentration on site would still, however, result in an HQ greater than one. Lead was detected in 48 percent of the samples collected. Detected concentrations ranged from 4.58 to 380 mg/kg with an average detected concentration of 35.8 mg/kg. Exposure of plants to the overall average lead concentration on site does not result in an HQ greater than one. Nickel was detected in 65 percent of the samples collected. Detected concentrations ranged from 4.82 to 38 mg/kg with an average detected concentration of 7.0 mg/kg. Exposure of plants to the overall average silver concentration on site does not result in an HQ greater than one. Silver was detected in 18 percent of the samples collected. Detected concentrations ranged from 0.12 to 13 mg/kg with an average detected concentration of 1.98 mg/kg. Exposure of plants to the overall average silver concentration on site does not result in an HQ greater than one. Based upon

Table 19
Hazard Quotients for Ecological Receptors Exposed to Background Concentrations for SWMU 85

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient (Herbivorous)	Deer Mouse Hazard Quotient (Omnivorous)[a]	Deer Mouse Hazard Quotient (Insectivorous)[a]	Burrowing Owl Hazard Quotient
Inorganic					
Barium	2.6E-1	3.3E-1	**1.1E+0**	**2.0E+0**	1.4E-2
Cadmium	1.7E-1	2.4E-2	2.5E-2	2.6E-2	8.1E-4
Chromium (total)	**1.6E+1**	2.8E-5	4.9E-5	6.9E-5	5.3E-2
Lead	2.4E-1	1.3E-2	1.0E-2	7.0E-3	6.9E-3
Mercury (inorganic)	1.7E-1	5.7E-4	5.7E-4	5.7E-4	1.0E-2
Mercury (organic)	1.7E-1	1.3E-1	1.3E-1	1.3E-1	7.1E-1
Nickel	3.8E-1	5.0E-3	7.1E-3	9.2E-3	4.3E-4
Selenium	5.0E-1	8.1E-2	1.5E-1	2.0E-1	3.3E-2
Silver	2.5E-1	2.3E-3	1.4E-3	6.0E-4	---[b]
Hazard Index[c]	**1.7E+1**	3.7E-1	**1.2E+0**	**2.0E+0**	7.5E-2

[a]**Bold** text indicates hazard quotient or hazard index exceeds unity.
[b]--- designates insufficient toxicity data available for risk estimation purposes.
[c]The hazard index is the sum of individual hazard quotients. Using the value for organic mercury as a conservative estimate of the hazard index.
SWMU = Solid waste management unit.

this analysis, vegetation associated with SWMU 85 are not expected to be at risk from exposure to lead, nickel, and silver. Barium was predicted to result in risk to the mouse following exposure to the maximum barium concentration from soil samples from within the 0 to 5 feet depth interval. Barium concentrations within this depth interval ranged from 44 to 400 mg/kg, with an average concentration of 118 mg/kg. Exposure of the owl to the average barium concentration on site would not result in an HQ greater than unity. In the case of HMX, the HQs for the deer mice (ranging from 6.0 to 12.0) are based on the maximum measured soil concentration of 8.4 mg/kg. This was, however, the only detection out of 44 soil samples (within the upper 5 feet of soil). The estimated (average HMX concentration for these samples (based upon one-half the detection limits) is 0.34 mg/kg, which results in a maximum HQ of about 0.5 in the deer mouse.

Based upon this uncertainty analysis, ecological risks at SWMU 85 are expected to be very low. HQs greater than unity were initially predicted, however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration, background risk, quality of analytical data, and the utilization of detection limits as exposure concentrations.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 85 were estimated through a screening assessment that incorporates site-specific information when available. Overall, ecological risks to plants are expected to be low because of the fact that predicted risks associated with exposure to chromium (total), lead, nickel, and silver are based upon calculations using maximum measured concentrations. With respect to the deer mouse, risk is also expected to be low. Predicted risk from exposure to barium and HMX was attributed to the use of maximum measured concentrations. Based upon this final analysis, ecological risks associated with SWMU 85 are expected to be insignificant.

VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as to whether the site should be recommended for NFA or additional data should be collected to assess actual ecological risk at the site more thoroughly. With respect to this site, ecological risks were predicted to be insignificant. The scientific/management decision is to recommend this site for NFA.

VIII. References

Baes, III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture," ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, Tennessee, pp. 10–11.

Baker, D.A., and J.K. Soldat, 1992. *Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment*, PNL-8150, Pacific Northwest Laboratory, Richland, Washington, pp. 16–20.

Brown, C.D. (Sandia National Laboratories). Memorandum to D. Jercinovic (IT), "Radiological Data Tables and DU Ratios." January 14, 1998.

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Whitmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould, 1979, "Water-Related Environmental Fate of 129 Priority Pollutants," EPA-440/4-79-029, Office of Water and Waste Management, Office of Water Planning and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Connell, D.W., and R.D. Markwell, 1990. "Bioaccumulation in Soil to Earthworm System," Chemosphere, Vol. 20, pp. 91-100.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB," September 24, 1997.

DOE, see U.S. Department of Energy.

Dunning, J.B., 1993. *CRC Handbook of Avian Body Masses*, CRC Press, Boca Raton, Florida.

EPA, see U.S. Environmental Protection Agency.

Haug, E.A, B.A. Millsap, and M.S. Martell, 1993. "*Speotyto cunicularia* Burrowing Owl," In A. Poole and F. Gill (eds.), *The Birds of North America*, No. 61, The Academy of Natural Sciences of Philadelphia.

IAEA, see International Atomic Energy Agency.

International Atomic Energy Agency (IAEA), 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards," Technical Report Series No. 332, International Atomic Energy Agency, Vienna, Austria.

IT, see IT Corporation.

IT Corporation (IT), July 1994. "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program," IT Corporation, Albuquerque, New Mexico.

IT Corporation (IT), February 1995. "Sensitive Species Survey Results, Environmental Restoration Project, Sandia National Laboratories/New Mexico," IT Corporation, Albuquerque, New Mexico.

IT Corporation (IT), July 1998. "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

Kocher, D.C. 1983, "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil," *Health Physics,* Vol. 28, pp. 193–205.

Ma, W.C., 1982. "The Influence of Soil Properties and Worm-related Factors on the Concentration of Heavy Metals in Earthworms," *Pedobiology*, Vol. 24, pp. 109–119.

Maxwell, C.J., and D.M. Opresko, 1996. "Ecological Criteria Document for Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) (CAS No. 2691-41-0)," Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Nagy, K.A., 1987. "Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds," *Ecological Monographs*, Vol. 57, No. 2, pp. 111–128.

National Council on Radiation Protection and Measurements (NCRP), 1987. "Exposure of the Population in the United States and Canada from Natural Background Radiation," National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP), 1989. "Screening Techniques for Determining Compliance with Environmental Standards: Releases of Radionuclides to the Atmosphere," NCRP Commentary No. 3, Revision of January 1989, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Oceanographic and Atmospheric Administration (NOAA), 1990. Local Climatological Data, Annual Summary with Comparative data, Albuquerque, New Mexico.

NCRP, see National Council on Radiation Protection and Measurements.

Neumann, G., 1976, "Concentration Factors for Stable Metals and Radionuclides in Fish, Mussels and Crustaceans—a Literature Survey," Report 85-04-24, National Swedish Environmental Protection Board.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, Santa Fe, New Mexico.

NMED, see New Mexico Environment Department

NOAA, see National Oceanographic and Atmospheric Administration.

Sample, B.E., and G.W. Suter II, 1994. "Estimating Exposure of Terrestrial Wildlife to Contaminants," ES/ER/TM-125, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B.E., D.M. Opresko, and G.W. Suter II, 1995. "Toxicological Benchmarks for Wildlife: 1996 Revision," ES/ER/TM-86/R3, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994. "Verification and Validation of Chemical and Radiological Data," Technical Operating Procedure (TOP) 94-03, Rev. 0, Sandia National Laboratories/New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1996. "RCRA Facility Investigation Work Plan for Operable Unit 1335, Southwest Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 11, 1997. "Bullets of Understanding between NMED/DOE OB and DOE/SNL ER Project for Sampling and Analysis Plans for ER Sites 14 and 85 OU 1335, Southwest Test Area," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1997. "OU 1335, ER Site 14, Confirmatory Sampling Plan," prepared by Sandia national Laboratories/New Mexico Environmental Restoration Project, Albuquerque New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998. "RESRAD Input Parameter Assumptions and Justification," Sandia National Laboratories/New Mexico Environmental Restoration Project, Albuquerque, NM.

Silva, M., and J.A. Downing, 1995. *CRC Handbook of Mammalian Body Masses*, CRC Press, Boca Raton, Florida.

SNL/NM, See Sandia National Laboratories, New Mexico.

Stafford, E.A., J.W. Simmers, R.G. Rhett, and C.P. Brown, 1991. "Interim Report: Collation and Interpretation of Data for Times Beach Confined Disposal Facility, Buffalo, New York," Miscellaneous Paper D-91-17, U.S. Army Corps of Engineers, Buffalo, New York.

Thomson, B.M. and G. J. Smith, 1985. Investigation of Groundwater Contamination Potential at Sandia National Laboratories, Albuquerque, NM, in Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984, CONF-841187, pp. 531-540.

Travis, C.C., and A.D. Arms, 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetables," Environmental Science and Technology, Vol. 22, No. 3, pp. 271-274.

USDA, see U.S. Department of Agriculture.

U.S. Department of Agriculture (USDA), 1977. "Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico," Soil Conservation Service, U.S. Department of the Interior Bureau of Indian Affairs and Bureau of Land Management, and New Mexico Agriculture Experiment Station, U.S. Government Printing Office, Washington, D.C.

U.S. Department of Energy (DOE), 1988. "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," DOE/EH-0070, U.S. Department of Energy, Assistant Secretary for Environment, Safety and Health, Washington, D.C.

U.S. Department of Energy (DOE), 1993. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," 1993.

U.S. Department of Energy (DOE), 1995. "Hanford Site Risk Assessment Methodology," DOE/RL-91-45 (Rev. 3), U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy and United States Air Force (DOE and USAF), March 1996. "Workbook: Future Use Management Area 7," prepared by the Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates and the U.S. Air Force.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., Update III, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988. "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), July 1990. "Corrective Action for Solid Waste Management Units (SWMU) at Hazardous Waste Management Facilities, Proposed Rule," *Federal Register*, Vol. 55, Title 40, Parts 264, 265, 270, and 271.

U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B)," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992. "Framework for Ecological Risk Assessment," EPA/630/R-92/001, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1993. "Wildlife Exposure Factors Handbook, Volume I of II," EPA/600/R-93/187a, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA). Memorandum from E. Laws, Assistant Administrator to Region Administrators I-X, "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Active Facilities," U.S. Environmental Protection Agency, Washington, D.C. July 14, 1994.

U.S. Environmental Protection Agency (EPA), 1996a. Draft Region 6 Superfund Guidance, Adult Lead Cleanup Level, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996b. "Region 9 Preliminary Remediation Goals (PRGs) 1996," electronic database maintained by Region 9, U.S. Environmental Protection Agency, San Francisco, California.

U.S. Environmental Protection Agency (EPA), 1997a. "Health Effects Assessment Summary Tables (HEAST), FY 1997 Update," EPA-540-R-97-036, Office of Research and Development and Office of Solid Waste and Emergency Response, Washington, D.C..

U.S. Environmental Protection Agency (EPA), 1997b. "Risk-Based Concentration Table," electronic database maintained by U.S. Environmental Protection Agency, Region 3, Philadelphia, Pennsylvania.

U.S. Environmental Protection Agency (EPA), August 1997c. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER Directive No. 9200-4-18, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997d. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1998a. Integrated Risk Information System (IRIS) electronic database, maintained by the U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (EPA), 1998b. "Guidelines for Ecological Risk Assessment," EPA/630/R-95/002F, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Department of Fish and Wildlife (USFWS), September 1995. "Migratory Nongame Birds of Management Concern in the United States: The 1995 List," Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

USFWS, see U.S. Department of Fish and Wildlife.

U.S. Geological Survey (USGS), 1994. National Geochemical Data Base: National Uranium Resource Evaluation Data for the Contiguous United States, U.S. Geological Survey Digital Data Series Dds-18-A, Washington, D.C.

Whicker, F.W., and V. Schultz, 1982. *Radioecology: Nuclear Energy and the Environment*, Volume II, CRC Press, Boca Raton, Florida.

Will, M.E., and G.W. Suter II, 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision." ES/ER/TM-85/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Yanicak, S. (Oversight Bureau, Department of Energy, New Mexico Environment Department). Letter to M. Johansen (DOE/AIP/POC Los Alamos National Laboratory), "(Tentative) list of constituents of potential ecological concern (COPECs) which are considered to be bioconcentrators and/or biomagnifiers." March 3, 1997.

Yu, C., A.J. Zielen, J.-J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, 1993a. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD,* Version 5.0. Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

Yu, C., C. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace, 1993b. "Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil," ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois.

Appendix 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Sandia National Laboratories (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land-use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. All three land-use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index (HI), risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of the following:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land-use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not currently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, Table 1 shows the exposure routes that will be considered. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations

Table 1
Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotient/HI, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
CR = contact rate for the exposure pathway
EFD = exposure frequency and duration
BW = body weight of average exposure individual
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

References

ANL, see Argonne National Laboratory.

Argonne National Laboratory (ANL), 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Table 2
Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (day/yr)	***	***	***
Exposure duration (yr)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 day/yr) for noncarcinogenic compounds (=ED x 365 day/yr)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day[c]	6.24 g/yr[d]	114 mg-yr/kg-day[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/day)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	*chemical specific*	*chemical specific*	*chemical specific*

***The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 hr/day for 250 day/yr; for the recreational land use, a value of 2 hr/wk for 52 wk/yr is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a]RAGS, Vol. 1, Part B (EPA 1991).

[b]Exposure Factors Handbook (EPA 1989b)

[c]EPA Region 6 guidance.

[d]For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e]Dermal Exposure Assessment (EPA 1992).

U.S. Department of Energy (DOE), 1996. "Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico," U.S. Department of Energy Kirtland Area Office.

U.S. Environmental Protection Agency (EPA), 1989a. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989b. *Exposure Factors Handbook*, EPA/600/8-89/043, U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B)," EPA/540/R-92/003, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992. "Dermal Exposure Assessment: Principles and Applications," EPA/600/8-91/011B, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996. "Soil Screening Guidance: Technical Background Document," EPA/540/1295/128, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

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